SESSIONAL PAPERS

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FOURTH SESSION

OF THE

FOURTEENTH LEGISLATURE

OF THE

PROVINCE OF ONTARIO

SESSION 1918

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1918

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No. 57 Report and supporting statements on Medical Education in Ontario, by Mr. Justice Hodgins, Commissioner. Presented to the Legislature, February 6th, 1918. *Printed.*

No. 58 Return to an Address to His Honour the Lieutenant-Governor, of the 20th March, 1917, praying that he will cause to be laid before the House—1. Copies of all Orders-in-Council approving of the agreement for the construction of the Hydro Radial Line from Toronto to Niagara Falls through Hamilton. 2. Copies of all reports, engineers' and otherwise, in reference to the cost and prospective earnings of the said railway furnished by the Hydro-Electric Power Commission to the Government. 3. Copies of all correspondence passing between the Hydro-Electric Power Commission and the Government in reference to the passing of the said Orders-in-Council and the construction of the said line. Mr. *Marshall.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 59 Return to an Order of the House of the 26th March, 1917, for a Return shewing:—1. How many leases of water-powers were issued by the Ontario Government in each of the years 1912, 1913, 1914, 1915, 1916 and down to March 1st, 1917. 2. To whom, in what districts, and for what periods of time were such leases of water-powers issued. Mr. *Dewart.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 60 Return to an Order of the House of the 7th March, 1917, for a Return shewing:—1. What areas of land of the Government of the Province of Ontario in Forest Reserve sections were overrun by fire in the years 1910, 1911, 1912, 1913, 1914, 1915 and 1916 respectively. Mr. *Ducharme.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 61 Return to an Order of the House of the 7th March, 1917, for a Return shewing:—1. How many patents of lands have been issued, under the Mines Act, in the District of Sudbury, to corporations, since February 8, 1905, in addition to the six patents of land issued to the Canada Copper Company on the 13th day of December, 1916. 2. To what corporations were such patents issued; on what dates; and in what townships were the lands situated. 3. Were the regulations with regard to timber preservation taken advantage of by those who staked claims, and were they so relieved from doing the necessary

development work required by the Mining Law of Ontario. If so, in what cases. Mr. *Dewart.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 62 Return to an Order of the House of the 23rd February, 1917, for a Return of Copies—1. All correspondence passing between the Government of Ontario, or any member, officer, or official thereof, and the Ontario Hydro-Electric Power Commission or any officer or official thereof, in reference to the purchase or acquirement of the properties of the Seymour Power Company. 2. All reports made by the Hydro-Electric Power Commission, or any member, officer or official thereof, in reference to the purchase of the properties of the said Seymour Power Company. 3. All valuations made by or on behalf of the Hydro-Electric Power Commission of the properties of the said Seymour Power Company. 4. All correspondence between the Government of the Province of Ontario, or any member, officer, or official thereof, and the Government of the Dominion of Canada, or any officer, or official thereof, in reference to the purchase or acquirement of the properties of the Seymour Power Company. Mr. *Carter.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 63 Return to an Order of the House of the 16th March, 1917, for a Return shewing:—1. What was the population of Ontario for each of the years from the year 1900 to 1916 inclusive. 2. What was the public debt of the Province of Ontario from the year 1900 to the year 1916 inclusive. 3. What was the public debt *per capita* for each of the years from the year 1900 to the year 1916 inclusive. Mr. *Pinard.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 64 Return to an Order of the House of the 14th March, 1917, for a Return of copies of all documents and correspondence passing between the Workmen's Compensation Board or any member, officer or employee thereof; the personal representatives of Archibald Taylor (deceased), late of Sarnia, Ont., or any person or persons acting on their behalf, and the Grand Trunk Railway Company or any employee or officer thereof. Mr. *Elliott.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 65 Return to an Order of the House of the 5th March, 1917, for a Return of—1. Copies of all correspondence, reports and documents in any way relating to the attempted arrest of one John W. Moyes. 2. What steps have been taken to effect such arrest and if it is the intention of the Government to continue its efforts to bring about the arrest of the said John W. Moyes. Mr. *Proudfoot.* Presented to the Legislature, February 6th, 1918. *Not printed.*

No. 66 Copies of Regulations and Orders-in-Council as required by Section 27 of the Department of Education Act. Presented to the Legislature, February 13th, 1918. *Not printed.*

No. 67 Statement *re* distribution of Revised and Sessional Statutes for the year 1917. Presented to the Legislature, February 20th, 1918. *Not printed.*

No. 68 Copies of Orders-in-Council in accordance with the provisions of ss. 6 of section 78 of the Surrogate Courts Act. Presented to the Legislature, February 26th and March 21st, 1918. *Not printed.*

No. 69 Return to an Order of the House, of the 25th February, 1918, for a Return shewing—1. What lands, if any, have been patented in the District of Sudbury, in the year 1917, to the following persons, respectively, Albert Harvey, Rinaldo McConnell, Alex. H. Beath and R. J. Tough. 2. On what dates were the said lands, if any, patented. 3. Have any terms been imposed in the Patents granted for any such lands so as to insure the treatment and refining of the Nickel Ores mined upon these properties in the Province of Ontario. 4. Is there any agreement or obligation on the part of the Company in question to which any such lands have been granted, which obligates them to carry on mining or other obligations, in the Province of Ontario, and if so what are the agreements or obligations and within what time limit must they be performed. Mr. *Dewart.* Presented to the Legislature, February 26th, 1918. *Not printed.*

No. 70 Contract of Agreement made with the Mounce Cartage Company, Limited, relating to the delivery of mail matter to and from the Toronto Post Office and the Parliament Buildings. Presented to the Legislature, February 27th, 1918. *Not printed.*

No. 71 Return to an Order of the House of the 26th February, 1918, for a Return shewing—1. What lands in the District of Sudbury, if any, have been granted to "John E. Hodge," of Minneapolis, Minn., in the U.S.A., since the 1st of March, 1917. 2. Is the said "John E. Hodge" connected with or representing any corporate interests, to the knowledge of the Government, and if so, what is the name of the corporation, and who are its officers. 3. Have any terms been imposed in such patents as have been granted, so as to ensure the treatment and the refining of the nickel ores mined upon this property in the Province of Ontario. 4. Is there any agreement, or obligation on the part of the grantees in question, obligating them to carry on mining or other operations in the Province of Ontario, and if so what are the agreements and obligations, and within what time limit must they be performed. Mr. *Dewart.* Presented to the Legislature, March 1st, 1918. *Not printed.*

No. 72 Return to an Order of the House of the 26th February, 1918, for a Return shewing—1. What lands, if any, have been patented in the District of Sudbury to "Sudbury Nickel, Limited," in the year 1917, and on what dates. 2. When was this company incorporated, with what share capital, and with what provisional directors. 3. What stock of the company has been issued (*a*) for cash; (*b*) for transfer of properties or claims, and to whom. 4. Who are the present directors of the company. 5. Have any terms been imposed in the patents granted for any such lands, so as to ensure the treatment and refining of the nickel ores mined upon any such properties in the Province of Ontario. 6. Is there any agreement or obligation on the part of the company in question to whom any such lands have been granted, which obligates them to carry on mining or other operations in the Province of Ontario, and if so what are the agreements or obligations, and within what time limit must they be performed. Mr. *Dewart*. Presented to the Legislature, March 1st, 1918. *Not printed.*

No. 73 Return to an Order of the House of the 26th February, 1918, for a Return shewing—1. What lands, if any, have been patented to the Canadian Copper Company in 1917, and at what dates. 2. Has the Government attached any restrictions to the patents granted to the said company, or taken any steps to ensure that the nickel recovered from the properties so granted shall be refined or otherwise treated in the Province of Ontario. Mr. *Dewart*. Presented to the Legislature, March 1st, 1918. *Not printed.*

No. 74 Interim Report on Venereal Diseases, with copy of an Act for the Prevention of Venereal Disease, by Mr. Justice Hodgins, Commissioner. Presented to the Legislature, March 5th, 1918. *Printed.*

No. 75 Return to an Order of the House of the 7th March, 1918, for a Return shewing—1. Copies of all correspondence between the Minister of Public Works, or any other members of the Government, or any official thereof, and any person or persons, and copies of any reports received by the Government, relating to the floods on the Grand River, since the return brought down by the House on the 3rd of April, 1913, being a preliminary study of the subject by H. G. Acres of the Hydro-Electric Power Commission. Mr. *Ham*. Presented to the Legislature, March 8th, 1918. *Not printed.*

No. 76 Return to an Order of the House of 25th February, 1918, for a Return shewing—1. What was the amount paid in by each of the following corporations in the year 1917, or the last period of twelve months for which returns are made, for all purposes under the Workmen's Compensation Act, namely: Massey-

Harris Co., Ltd., John Inglis Co., Ltd., Toronto Carpet Mfg Co., Harris Abattoir Co., Ltd., Park, Blackwell Co., Ltd., Dominion Radiator Co., Ltd. 2 What amount was paid out in the same period under the Act to the employees of each of the said companies, for claims made for injuries during the said period. 3. What amount, if any, was held, under the Act, for further payments on claims made in the same period for injuries by such employees of each of the said companies. Mr. *Dewart.* Presented to the Legislature, March 11th, 1918. *Not printed.*

No. 77 Return to an Order of the House of the 27th February, 1918, for a Return shewing—1. Copies of all correspondence between the Government, or any officer or official thereof, and any person or persons, in reference to the purchase of additional land and the erection of buildings thereon, and all items in connection therewith, referred to in Vote No. 156, relating to the Hospital for the Insane, Kingston, appearing on Page 35 of the Supplementary Estimates for the Fiscal Year ending October 31st, 1918. Mr. *Dewart.* Presented to the Legislature, March 11th, 1918. *Not printed.*

No. 78 Memorandum on the Natural Gas Situation in Kent, Essex and Lambton. Presented to the Legislature, March 15th, 1918. *Printed.*

No. 79 Report on the Ontario Parole Board for the year 1916-17. Presented to the Legislature, March 20th, 1918. *Printed.*

No. 80 Budget Speech of the Provincial Treasurer, delivered in the House on the 12th February, 1918. *Not presented. Printed.*

No. 81 Telephone Systems—Statistical information and Acts relating to. *Not presented. Printed.*

No. 82 Report of Bureau of Municipal Affairs for the year 1917. Presented to the Legislature, March 21st, 1918. *Not printed.*

No. 83 Order-in-Council of 21st March, 1918, designating the Hospitals, Refuges, Orphanages and Infants' Homes, to which aid may be granted under the Hospitals and Charitable Institutions Act. Presented to the Legislature, March 21st, 1918. *Not printed.*

No. 84 Return to an Order of the House of the 7th March, 1917, for a Return shewing—1. What was the number and kind of pelts or skins of fur-bearing animals coming into the possession of the Government of the Province of Ontario during the years 1910, 1911, 1912, 1913, 1914, 1915, and 1916, respectively, because of violation of any law or laws relating to fur-bearing animals. 2. What disposition of such pelts or skins has been made by the Government. 3. And what price or prices for

each kind of fur, and to whom have the aforesaid pelts or skins been disposed of by the Government. Mr. *Ferguson* (Kent). Presented to the Legislature, March 21st, 1918. *Not printed.*

No. 85 Report of the Soldiers' Aid Commission of Ontario for the year 1917. Presented to the Legislature, March 21st, 1918. *Not printed.*

No. 86 Return to an Order of the House of the 6th March, 1918, for a Return shewing—1. How many civil servants were released during the past year for work on Ontario farms. 2. What are the names of such employees. 3. How long were they so employed. 4. What are the names of the parties by whom they were employed. Mr. *Ham.* Presented to the Legislature, March 21st, 1918. *Not printed.*

No. 87 Return to an Order of the House of the 20th March, 1918, for a Return shewing—1 (*a*) How many copies of the Report relating to the registration of births, marriages and deaths in the province for the year 1916, were published. (*b*) How many were distributed. 2. What was the cost of printing and publication. 3 (*a*) How much would the cost have been reduced if the Report had been confined to the first 57 pages. (*b*) How much, if confined to the first 154 pages. 4. How many officials and clerks were employed in the preparation of the copy of the said Report for the printer, and for what approximate time and at what estimated cost. Mr. *Dewart.* Presented to the Legislature, March 21st, 1918. *Not printed.*

REPORT

OF THE

Minister of Lands, Forests and Mines

OF THE

PROVINCE OF ONTARIO

For the Year Ending 31st October

1917

PRINTED BY ORDER OF
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Bridal Veil Falls at Kagawong, Manitoulin Island, on the highway between Little Current and Gore Bay.

Report of the Minister of Lands, Forests and Mines of the Province of Ontario

For the Year Ending 31st October, 1917

To His Honour the Lieutenant-Governor of the Province of Ontario.

MAY IT PLEASE YOUR HONOUR:

I have the honour to submit for the information of your Honour and the Legislative Assembly a report for the fiscal year ending 31st October, 1917, of the management of the Crown Lands of the Province.

CLERGY LANDS.

The collection on account of Clergy Lands was $976.78. No land was disposed of during the year. (See Appendix No. 4, page 9.)

COMMON SCHOOL LANDS.

The collection on account of former sales was $3,333.59. (See Appendix No. 4, page 9.)

UNIVERSITY LANDS.

The area of these lands sold during the year was 2,074.73 acres for $1,802.37. The collection on account of these and former sales was $2,598.91. (See Appendix No. 3, page 8.)

CROWN LANDS.

There was sold during the year for agricultural and town site areas 109,303.53 acres for $78,105.76. The collection on account of these and former sales was $63,079.87. There was sold for mining purposes 20,154.31 acres for $52,985.64. There was collected on account of these and former sales $57,054.50.

There was leased for mining purposes 4,962.29 acres for $4,722.44. There was collected on account of these leases and those of former years $16,884.67. There was leased of Crown lands an area of 29,068.88 acres for $3,245.09. There was collected on account of these and the leases of former years $62,845.01.

The total area of Crown lands disposed of by sale and lease during the year was 165,628.06 acres for a value of $140,948.30, as compared with 133,447.01 acres sold and leased in 1915 for $113,397.18. The total collection on account of the sales, leases, etc., was $208,551.69. (See Appendix No. 3, page 8.)

Sales.

During the fiscal year ending 31st October, 1917, there were disposed of for settlement purposes under Part I, of the *Public Lands Act,* approximately 104,000 acres, an area slightly in excess of the previous year. The number securing farms in Northern Ontario throughout the Temiskaming and Hearst Sections was, as might be expected, somewhat less than the preceding period. When the war conditions are considered and the labour and industrial situation is taken into account, with the demand for the application of productive forces apart from the farm and field, it is a source of gratification to find that over 650 new land seekers purchased farms in Northern Ontario in the past year. With immigration inactivity the source of supply for colonists must necessarily be very largely, if not wholly, our own Province, and with this limited field before us it cannot be reasonably expected that land settlement will, during the progress of hostilities, attain anything like the standard it should reach in normal times. The universal appeal on the part of governments and astute economists throughout the British Empire has, undoubtedly, set many thinking and urged numbers to seriously consider the necessity of trekking back to the land.

Hundreds of Northern Ontario settlers are serving their country at the front, and many have already paid the supreme sacrifice. The Department has, since the outbreak of the Great War, extended to the enlisted soldier protection against the jumping of his claim, and will, on his return, render him every opportunity of meeting the necessary requirements incidental to acquiring absolute title to his land.

For the first time in its history the annual report contains in detailed form a statement showing the different land agencies throughout the Province, with the townships comprising each and the number of land transactions recorded in townships other than Free Grant. A cursory glance will disclose the number of sales, patents, etc., in the respective townships and hereafter the public will have ready access to this information, as it has always had to similar information in respect of Free Grant operations. With a view of checking up spurious land holders, who pose as bona fide settlers and of eliminating them to make way for active farmers, the Department made a special examination of some of the more important townships on the Transcontinental Railway. This resulted in cancelling a number of claims and withdrawing from further sale the townships of Calder, Shackleton, Eilber, Fournier and Kendal. These areas may later on be utilized in dealing with a further development of the Returned Soldiers' Scheme. (See Appendix No. 15.)

Consideration has been given to the question of more carefully scrutinizing the class of individuals seeking land.

In the sale or allocation of Crown Lands of the Province each applicant has always been required, preliminary to being eligible for land, to make an affidavit subscribing to certain statements as to his age, his desire to become a settler, and his intentions of performing the settlement duties as prescribed by law; but the would-be settler has not been called upon heretofore to state his birth-place, his nationality or his intentions to become a British subject, if not already one; nor has any provision in the past been made requiring a declaration of obedience to all the laws in force in the Province, both Dominion and Provincial.

In the absence of such data as implied in the last mentioned requirements, it has been impossible to keep fully seized in each case of important facts as respects the individual applicant, whose desirability as a settler is most essential.

For the purpose of securing and maintaining a desirable class of settlers on the Crown Lands of the Province and of being fully apprised of the nationality and law-abiding intentions of would-be locatees, and, furthermore, with a view of aiding and urging a win-the-war policy, and at the same time promoting the cause of greater production, certain detailed information, in addition to that heretofore furnished by applicants, will hereafter be required.

Also for the purpose of more effectively discouraging and preventing "squatting" or unauthorized possession of Crown Lands, and of more readily enforcing the laws and regulations as regards land settlement, it was deemed expedient that individual applicants should be made to realize the importance and necessity of faithfully meeting their obligations, both to the Province of Ontario and the Dominion of Canada, and should be required to subscribe to adequate promises incidental to being eligible to purchase or locate lands.

Applicants from this time on must state their nationality, and if not British, promise to take steps to become naturalized and to obey unreservedly all the laws and regulations, both of the Dominion of Canada and Province of Ontario, under the penalty of forfeiting all rights in or to the land or money paid on account of same.

Ranching Leases, Licenses, Etc.

While only one ranching lease of any size was issued throughout the year, inquiries continue to reach the Department from many quarters as to grazing possibilities. The importance and necessity of increasing stock production has given an impetus to the cattle and sheep raising industry, and with an annual rental of only five cents an acre per annum and easy conditions as to stocking offered by the Province of Ontario, substantial development in this business should be looked for. While no technical attempt has yet been made to segregate the various grazing areas from those that are primarily agricultural, etc., the Department holds in readiness for the service of those likely to be interested in promoting the cause of ranching on Crown areas, certain information preliminary to enabling would-be ranchers going personally over areas and making a selection on their own behalf.

In addition to the one grazing lease there were twenty-three Crown Leases issued during the year for water power and other purposes.

Licenses of Occupation to the number of fifty-three were issued and these covered for the most part authority to occupy mining claims although other purposes were represented: mill sites, water lots, power lines, ranching, public sites, water mains and fur farms. These licenses are made subject to the pleasure of the Crown and thus their elasticity is ample protection to the public interests. For the rights to secure sand and gravel, licenses to the number of twenty-two were issued during the year.

Under Appendix No. 8 may be seen a statement of all the instruments including patents, etc., issued for the entire fiscal year.

Free Grants.

A slight reduction is found in the number of Free Grant locations carried out for the fiscal year ending October 31st, 1917: the number of locatees being 610 for an area of 78,192 acres, while 620 secured land in 1916 covering 85,139 acres. There were 147 locatees who availed themselves of the statutory privilege to pur-

chase additional areas and in this way obtained 6,210 acres; last year 155 purchased for 5,191 acres, so that the average parcel purchased during the past year is somewhat larger.

Certain locatees, numbering 217, for good and sufficient reasons, were allowed to sell their improvements and assign their locations, their assignees succeeding to their rights and obligations.

In Free Grant townships 449 patents were issued to parties, the great majority of whom were actual settlers who had completed their residence and other settlement duties. The other patentees were those who had acquired title for summer resort purposes.

No new townships were placed on the market during the year. Generally speaking the transactions in respect of Free Grant lands and Homesteading were practically the same as in the preceding year, although the numbers seeking free homesteads have very naturally decreased and this is borne out by the figures as compiled in detail under Appendix No. 14.

The obvious lull is due partly to war conditions and partly also to the gradual lessening of ready accessible, arable Free Grant lands. The old sections have been largely sought in the past and, of the Free Grant lands now open, only a small percentage of the first-class farming areas remains. In the earlier development of land settlement the Free Grant sections were eagerly seized upon, and in this way practically all the Rainy River Valley has been settled as well as Thunder Bay District, and a goodly proportion of the agricultural sections of Kenora. The fact that within recent years the new townships opened have been in the Great Clay Belt and are subject to Sale Regulations, has noticeably affected the tabulated results in Free Grants. Moreover, in 1915 several townships in the Sudbury section were withdrawn because of their inclusion in the sulphur area.

With the older arable portions of townships cruised and well settled, with no new lands being opened for Free Grants, and with the standstill condition of immigration and other war tendencies, it is not unreasonable to presume that for the continuance of the war, at least, there will be no appreciable increase in the number of Free Grant settlers.

Military Grants.

The total number of Military Certificates issued to date, under the Veterans Land Grant Act, 1 Edw. VII, Cap. 6, and amendments thereto, is 13,998. During the year 96 letters were received from men or from the next of kin of veterans who had served on the frontier during the Fenian Raid, but had only now heard of this grant and asked for application forms. As the time for receiving these applications expired on 30th September, 1908, these application forms could not be sent to them.

During the year there have been 87 certificates located covering 13,986 acres in the townships open for veterans, making in all a total of 8,261 certificates located.

There were 3 certificates surrendered to the Crown for the $50.00 commutation money; this makes a total of 3,257 certificates surrendered.

In 14 cases the certificates have been surrendered and applied in payment of lands purchased from the Crown, covering in all 2,240 acres, making a total of 774 certificates that have been applied in this manner.

During the year there have been 158 patents issued for lands located by veterans, making a total of 7,222 thus disposed of.

The total number, therefore, of certificates that have now been redeemed is 12,355, leaving 1,643 still outstanding.

Under the Act 1st Edw. VII, Cap. 6, and amendments thereto covering these grants it is necessary for all locatees of the lands granted under this Act to apply for their patents for such land before ten years have expired from date of location. If this application for patent is not made within the ten years then the land comes under the settlement regulations, and unless the settlement duties are proceeded with, the locations are liable to cancellation. Previous to the expiration of the ten years after location, the Department has sent a notice to each veteran who should apply for his patent stating this fact, and in this manner have saved many of the locations from becoming subject to the settlement duties. See Appendix No. 11, page 53.

Financial Assistance to Settlers.

Since August 12th, 1916, 1,238 applications for loans have been dealt with by the Settlers' Loan Commissioner. Loans amounting to $383,968.57 have been made.

There is no doubt as to the benefit which has been derived by the settlers from the advances which have been made by the Department. In many cases reports have come to the Department of settlers being enabled to remain on their clearings and devote their whole time to work on their holdings, securing results that otherwise they would have been unable to accomplish.

Production in Northern Ontario during the coming season will clearly demonstrate the benefits derived from the loans which have been made.

For particulars *re* loans refer to Appendix 28.

The Mining Industry.

The annual reports of the Bureau of Mines deal fully with the mining industry of the Province, and it is, therefore unnecessary to go into detail on this subject here. Statistics of production of the metalliferous mines and works of Ontario for the nine months ending 30th September, 1917, have been collected by the Bureau and may, however, be given. The metallic output for the calendar year may be closely approximated from these figures. The value of the mineral production of the Province is now upwards of sixty-five millions of dollars per annum, and Ontario easily leads all the other Provinces in this branch of industrial activity. The steady growth of mining in Northern Ontario, by providing a ready home market for farm products, is proving, and will continue to prove, one of the chief factors in the settlement and colonization of the agricultural areas of the Crown domain.

The table is as follows, and for purposes of comparison, figures for the corresponding period of 1916 are also given:

Notwithstanding the falling off in the output of gold, silver and copper, the aggregate value for the nine months was some $2,000,000 more than for the same

period in 1916. Increased prices for silver, copper and nickel are largely responsible for this increase:

		Quantity.		Value $	
		1916	1917	1916	1917
Gold	ounces	363,955	343,490	7,513,734	6,754,535
Silver	"	16,203,091	15,236,002	9,750,040	12,001,875
Cobalt (metallic)	lbs.	172,055	295,866	146,467	433,739
Nickel "	"	17,435	166,921	7,618	67,499
Nickel (oxide)	"	54,152	10,831	6,381	3,025
Cobalt "	"	378,732	276,769	231,947	323,162
Other Cobalt and Nickel compounds	"	57,026	276,217	22,890	30,025
Molybdenite	"	15,845	65,827	15,845	83,550
Copper ore	tons	1,715	2,658	21,685	33,419
Nickel in matte	"	31,046	31,064	15,523,000	15,532,000
Copper in matte	"	16,989	15,928	6,285,930	6,371,200
Iron ore (exported)	"	....	98,757	....	412,401
Pig Iron from domestic ore	"	....	48,820	....	936,118
Lead	"	....	540	....	136,948
Total					43,119,496

Gold.—Of the total production, the Hollinger mine yielded 161,702 ounces; McIntyre, 59,779 ounces; and Dome, 58,978. Gold being the standard of value, and having a fixed price, was the only metal which did not share in the general increase of prices. Indeed, the high price of labour and supplies have, for the time being, lowered the rate of expansion for this branch of the industry. The output for the first nine months of this year was some 20,000 ounces less than for the corresponding period of 1916.

Evidence accumulates that the gold resources of Northern Ontario are extensive. Developments at Porcupine have been satisfactory, and Kirkland Lake shows signs of being a good second. A satisfactory feature is that the newer gold camps are scattered over a wide area of territory.

Silver.—The average price of silver was 79.758 cents—the low being 71.75 on March 27th, and the high 108.50 on September 25th. The following mines were the leading shippers: Mining Corporations of Canada, 3,831,211 ounces; Nipissing, 2,839,462 ounces; Kerr Lake, 1,708,921 ounces; Coniagas, 976,315 ounces; O'Brien, 925,000 ounces; McKinley-Darragh-Savage, 775,566 ounces; Miller Lake O'Brien, 757,132 ounces.

Nickel and Copper.—Both these metals have risen in price, and are valued in these statistics at 25 cents and 20 cents per pound, respectively, for the metallic contents of the mattes produced. Nickel is quoted at 50 to 55 cents per pound, and the United States Government has now fixed the price of copper at 23½ cents per pound. The mines of Sudbury are now, and have been for some time, working at maximum capacity. The nickel contents of the mattes for the nine months of 1917 were a little larger than for the same period in 1916, but the copper contents were about 1,000 tons lower. The International Nickel Company's new refinery at Port Colborne is well under way, and is expected to be turning out refined nickel before next spring.

Iron Ore and Pig Iron.—In addition to exported ore, 138,808 tons were shipped to Ontario smelters. Of the total of 983,321 tons of ore smelted, only 93,536 tons, or 9.5 per cent., were Ontario ore. The total pig iron produced was 513,232 tons, worth $9,841,438 as compared with 501,410 tons, worth $6,686,965 in 1916 for the corresponding period. This shows an advance of nearly 50 per cent. in the value of pig iron.

Collections.

The total revenue of the Department from all sources was $3,579,196.06. Of this $63,079.87 came from agricultural lands and town sites; mining lands $57,054.50; mining and crown leases $80,544.18; miners' licenses, permits and recording fees $62,256.41; supplementary revenue tax $1,557,543.37. From woods and forests the revenue was $1,695,703.08 made up of the following items, bonus $640,835.35; timber dues $832,467.24; ground rent $100,408.33; transfer fees $6,665.10; fire protection charge $115,327.06. (See Appendix No. 4, page 9.)

Disbursements.

The total expenditure of the Department for ordinary services was $903,154.27. Some of the principal items were: Crown Land agents' salaries and disbursements $16,861.54; homestead inspectors $16,333.25; Crown timber agents $32,040.62; wood ranging and estimation of timber $120,152.20; fire ranging $337,933.50; forest reserves, fire ranging, etc., Temagami reserve $39,694.04; Metagami reserve $8,252.02; Mississaga reserve $26,854.08; Nipigon reserve $27,752.36; Eastern reserve $2,704.17; Sibley reserve $100.00; mines and mining $52,578.65; mining records $25,925.15; surveys $43,214.75; contingencies, lands and forests $48,-137.30; bureau of mines $10,362.50.

A further sum of $88,554.93 was expended under the direction of the Department, distributed as follows: Algonquin Park $33,623.89; Quetico Provincial Park $9,056.50; Veteran's Commutation $150.00; Royal Nickel Commission $45,721.64. (See Appendices Nos. 5 and 6.)

Woods and Forests.

The accrued revenue from woods and forests for the year ending 31st October, 1917, amounted to $1,496,063.45 or $90,638.39 in excess of previous year.

The revenue collected also shows a satisfactory increase over preceding year, $1,695,703.08 being collected as against $1,335,320.78 for year ending 31st October, 1916, an increase of $360,382.30.

The production of pine timber—saw logs and dimention timber—is nearly one hundred million feet board measure less than that of previous season, and almost two hundred million feet, board measure, less than that for year ending October 31st, 1915. The falling off in production of timber other than pine was not so marked, being only one million four hundred and seventy-seven thousand eight hundred and sixty-three feet, board measure, less than previous year.

While the production of pine timber has steadily declined, shortage of labour, due to the war, has contributed largely to the falling off of the past two years. The lumber firms have experienced great difficulty in manning their camps and in many cases have been forced to lessen the number of camps.

The number of railway ties taken out was more than double the number of cut during previous season; 1,544,826 were taken out as compared with 738,597 in 1916.

Two hundred and twenty-two thousand three hundred and seven cords of pulpwood was cut upon settler's lands during season 1916-17. Total number of cords of pulpwood cut on settler's lands and lands of the Crown, 445,978.

Two hundred and twenty-three thousand six hundred and seventy-one cords of pulpwood was taken off Crown lands, season 1916-17, an increase over previous season of 54,158 cords.

Sales of the Pic River Pulp and Timber Limit and Black Sturgeon Pulp and Timber Limit referred to in 1916 report were carried out, the highest price ever tendered for pulpwood being obtained.

Recently what is known as the Kapuskasing Pulp and Timber Limit was offered for sale. These three limits add 3,594 square miles to the area of pulp lands covered by concessions.

Lands Under License.

The area under license last year was 16,313¾ square miles, which was 601½ square miles greater than the area under license the previous season.

Sources of Revenue.

The ground rent received amounted to $100,408.33, being $11,190.84 more than in the preceding year.

Six thousand six hundred and sixty-five dollars and ten cents was collected as transfer fees as against $3,640.00 for 1916.

Licensees and other holders of timber concessions were required, under the terms of the new Regulations, to pay a fire protection charge of $6.40 per square mile, and the amount received from this source totalled $115,327.06.

The revenue collected during the year ending October 31st, 1917, was made up as follows:

Timber Dues	$832,467 24
Bonus	640,835 35
Ground rent	100,408 33
Transfer Fee	6,665 10
Fire Protection	115,327 06
	$1,695,703 08

Culler's Examination.

Two Culler's Examinations were held during the year, one at North Bay and the other at Kenora. Eight candidates succeeded in passing the examination and were duly granted certificates authorizing them to act as Cullers.

(For complete list of Cullers see Appendix 12, page 54.)

Fire Ranging.

Under the legislation passed during the Session of 1917 radical changes were made along the line of forest protection.

The Permit System, relating to the burning of slash by settlers, was inaugurated, 3,486 permits, covering 15,186 acres, being issued during the past season by

members of the fire ranging staff. Generally speaking, the settlers co-operated heartily, and results amply justify the new regulation.

The area protected was divided into thirty-four districts, each in charge of a Chief Ranger. Over the Chief Ranger were three territorial Inspectors, with headquarters at Cochrane, Nipigon and North Bay. The general field work was supervised by a Provincial Superintendent.

The number of rangers was largely increased, owing to the addition of rangers on licensed lands, the introduction of the permit system, and the protection of areas where none had previously existed.

Forest Fires.

The weather in the early part of the fire season was dry, and a number of fires of some magnitude occurred in the western part of the Province, fortunately attended by no loss of life. A total of 1,110 fires was reported, the greater number being of small extent. Five hundred and forty-nine of the fires reported were caused by railways—the Canadian Government railways being responsible for 332 of this number. The neglected camp fire was a fruitful source of fires. Only 8 per cent. of the total number of fires was caused by settlers clearing land—an ample justification of the Permit System.

Improvement Work.

During the season 62 Lookout Towers were constructed, 26 Observation points were built, numerous trails were cut and a considerable addition was made to the existing telephone system. Four large storehouses for equipment were built, also 44 rangers' cabins, 3 boathouses, 3 hose houses, and numerous other improvements of a minor nature.

Equipment.

It was found necessary to add largely to the equipment during the past season. Twenty-eight railway velocipedes were added to the stock and a number of auto-trucks and motor boats were installed where such equipment could be used to best advantage.

Forestry.

The work of forest planting is necessarily hampered by the shortage of labour owing to war conditions. Valuable work is, however, being accomplished at the Provincial Forest Station in Norfolk County.

A complete summary of the activities of the Forestry Branch will be found in Appendix 34.

Crown Surveys.

The following surveys of Crown lands have been completed during this year:

Islands in Lake Huron, north of Manitoulin Island, district of Algoma.

Islands in Lake Huron, north of Manitoulin Island, district of Manitoulin.

Islands in Georgian Bay, district of Sudbury.

Part of south boundary and east boundary, Nepigon Forest Reserve, district of Thunder Bay.

Township of Foleyet, district of Sudbury.

Township Muskego, district of Sudbury.

Part of the township of Keith, district of Sudbury.

Survey of outlines of townships of Wickstead, Haig and Farquhar, district of Algoma.

Boundary line between the townships of Gooderham and Kenny, district of Nipissing.

Survey of lakes Mesomikenda and Minisinakawa, district of Sudbury.

Survey of town plot on Bear Island, Timagami Lake, district of Nipissing.

Timber lines in the townships of Ogden, Bristol and Thornloe, district of Timiskaming.

Timber lines in the township of Notman, district of Nipissing.

Timber lines in the township of Sweeny, district of Sudbury.

See Appendix No. 16, page 76.

For Crown Surveys in progress, see Appendix No. 17, page 77.

Municipal Surveys.

Seven municipalities petitioned for surveys and instructions were given authorizing the same. One of these and four other municipal surveys, for which instructions had previously been given, were confirmed during the year under R.S.O. 1914, Cap. 166, Sections 13 and 14, such surveys being final and conclusive.

The survey of the Toronto and Hamilton Highway, between the westerly limit of the city of Toronto and the westerly limit of the town of Oakville, was also performed under instructions as required by Statute 5, George 5th, Cap. 18, and the boundaries of such portion of the highway as defined by the survey duly confirmed.

Particulars relating to these will be found in Appendices No. 18 and No. 19, pages No. 78 and No. 79.

Returned Soldiers and Sailors—Land Settlement.

In the spring of 1917 the Land Settlement Scheme for returned soldiers was put in operation. In adopting the plan of settlement which had been decided upon it was endeavoured to devise a system which would result in placing considerable numbers of returned men on the land in communities, having a common centre, avoiding in large measure the isolation which unfortunately has prevailed in many of the northern districts.

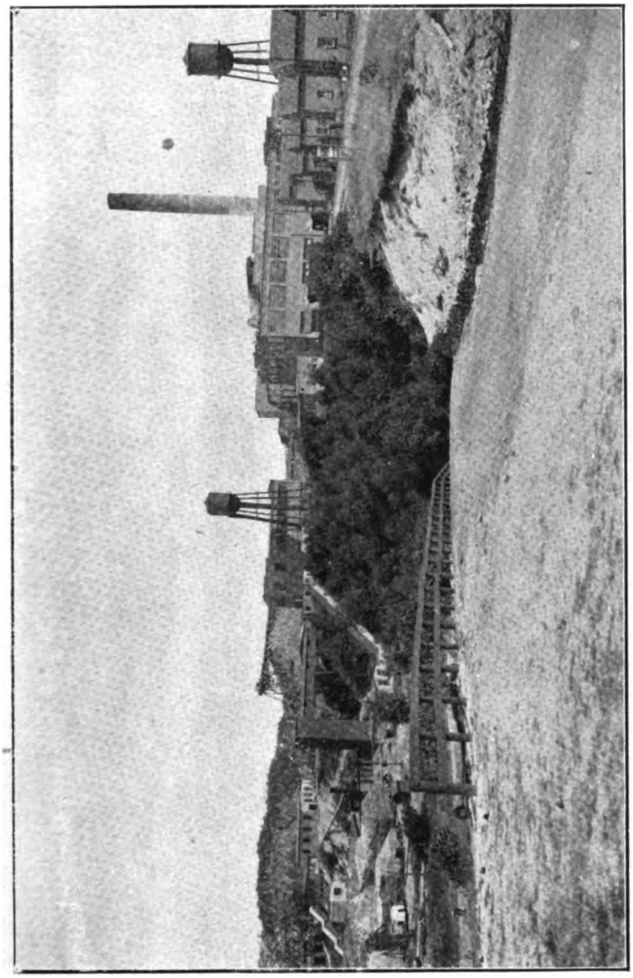
The work of the past year has naturally been largely experimental, but the result, to date, has been sufficiently satisfactory to warrant a very considerable extension of the scheme for the coming season.

Report as to the work that has been accomplished will be found in Appendix No. 35.

G. H. Ferguson,

Minister.

Department of Lands, Forests and Mines,
Toronto, October 31st, 1917.



Spanish River Pulp and Paper Mills at Espanola.

APPENDICES

Appendix No. 1.

Return of Officers and Clerks of the Department of Lands, Forests and Mines for the year ending October 31st, 1917.

Branch.	Name.	Designation.	When Appointed.	Salary per annum.	Remarks.
	Hon. G. H. Ferguson	Minister	1914, Dec. 22	$6,000 00	
	Albert Grigg	Deputy Minister	1915, Oct. 13	4,200 00	
	C. C. Hele	Minister's Secretary and Secretary to Department	1912, Jan. 23	2,500 00	
	J. Farrington	Clerk	1916, Jan. 6	1,200 00	
	A. G. Thompson	do	1909, Mar. 24	900 00	
	M. Johnston	Stenographer	1915, Oct. 9	750 00	Resigned April 30, 1917.
Lands Branch	J. J. Murphy	Advisory Chief Clerk	1872, May 1	2,300 00	
	W. C. Cain	Chief Clerk	1903, Mar. 6	2,100 00	
	H. E. Johnston	Clerk of Military Grants	1907, Mar. 13	1,750 00	
	W. R. Ledger	Clerk of Sales	1894, Feb. 5	1,600 00	
	S. Draper	Clerk of Free Grants	1903, Jan. 1	1,500 00	
	S. A. Platt	Clerk	1907, Mar. 13	1,150 00	
	F. Lucas	do	1909, Mar. 24	1,200 00	
	J. E. Drinkwater	do	1916, May 3	1 200 00	
	C. S. Jones	Clerk of Patents	1890, May 22	2,050 00	
	W. S. Sutherland	Engrossing Clerk	1902, Jan. 13	1,450 00	
	C. E. Burns	Reference Clerk	1900, Apr. 9	1,550 00	
	W. Carrell	Engrossing Clerk	1904, Jan. 15	1,350 00	
	A. E. Robillard	do do	1894, May 8	1,100 00	
	A. E. Roe	Clerk of Registers	1909, Mar. 24	1,350 00	
	N. MacQueen	Stenographer	1909, Mar. 24	800 00	Resigned October 31, 1917.
	M. Bengough	do	1896, Oct. 23	800 00	
	J. C. Oram	do	1907, Jan. 16	800 00	
	E. F. O'Neil	do	1904, Nov. 9	800 00	
	E. G. Halliday	do	1909, Mar. 24	800 00	
	B. M. Benson	do	1911, Mar. 3	750 00	
	E. Hills	do	1916, May 3	750 00	
	G. B. Kirkpatrick	Director	1866, Jan. 30	2,700 00	Died August 3, 1917.
	L. V. Rorke	Assistant Director	1909, May 5	3,000 00	
	J. Hutcheon	Surveyor and Draughtsman	1913, May 20	2,500 00	
	W. F. Lewis	Clerk	1872, Feb. 5	1,400 00	

Surveys	D. G. Boyd	Draughtsman	1897, Sept. 27	1,750 00
	E. M. Jarvis	Clerk	1904, Oct. 19	1,500 00
	J. B. Proctor	do	1897, Jan. 15	1,300
	B. Rushford	Draughtsman	1912, Oct. 5	1,100 00
	F. E. Blanchet	Clerk	1907, Mar. 13	1,200 00
	A. Leaman	do	1909, Mar. 24	1,200 0
	H. Treeby	Draughtsman	1904, Jan. 13	1,350 00
	J. Work	do	1911, Mar. 3	1,350 00
	H. M. Kirkland	Stenographer	1904, Nov. 23	800 00
	C. O'Connor	do	1911, Mar. 3	700 00
	E. C. Armer	do	1911, Mar. 3	700 00
Woods and Forests	J. A. G. Crozier	Advisory Chief Clerk	1867, Dec. 1	2,300 00
	J. Houser	Chief Clerk	1907, Mar. 13	2,000 00
	J. B. Cook	Clerk	1898, Aug. 1	1,850 00
	H. Gillard	do	1900, Apr. 9	1,600 00
	F. J. Niven	do	1903, Mar. 6	1,550 00
	W. F. Trivett	do	1904, Jan. 13	1,400 0
	R. H. Hodgson	do	1904, Nov. 23	1,300 0
	A. H. O'Neil	do	1909, Mar. 24	1,100 00
	G. W. Harris	do	1909, Mar. 24	1,100 00
	N. L. Rogers	do	1911, Nov. 2	1,200 00
	S. D. Meeking	do	1910, May 12	1,000 00
	E. H. Squire	do	1916, Apr. 6	1,000 00
	E. H. Telfer	do	1916, Apr. 6	900 00
	C. Rowland	Stenographer	1915, Mar. 23	800 00
	W. A. Fleming	do	1915, Feb. 16	700 00
	M. E. Bliss	do	1909, Sept. 1	800 00
	H. Canton	do	1915, Oct. 9	700 0
Accounts	D. G. Ross	Accountant	1861, Apr. 15	2,650 00
	H. M. Lount	Clerk	1904, Jan. 13	1,650 00
	C. J. Clarke	do	1907, Mar. 13	1,250 00
	R. Gordon	do	1913, Apr. 20	1,100 00
	W. A. Burritt	do	1908, Apr. 8	1,250 00
	C. Bowland	Clerk and Stenographer	1911, Mar. 3	800 00
Forestry	E. J. Zavitz	Provincial Forester	1912, Nov. 7	3,500 00
	J. H. White	Assistant Provincial Forester	1917, Apr. 1	3,000 00
	F. S. Newman	Forester	1913, Sept. 22	1,700 00
	J. Bald	Stenographer	1914, Oct. 28	700 00

Appendix No. 1.—Concluded.

Return of Officers and Clerks of the Department of Lands, Forests and Mines for the year ending October 31st, 1917.

Branch.	Name.	Designation.	When Appointed.	Salary per annum	Remarks.
Colonization	H. A. Macdonell	Director	1912, Feb. 2	2,450 00	
	J. Thompson	Clerk	1906, Jan. 24	1,800 00	Died September 21, 1917.
	J. Argue	do	1908, Apr. 8	1,600 00	
	R. A. Jones	do	1909, Mar. 8	1,500 00	
	C. W. Garthwaite	do	1910, Nov. 4	1,200 00	
	H. Tutt	do	1911, Mar. 30	1,100 00	
	S. O. Dennis	Clerk and Stenographer	1910, Nov. 4	800 00	
	R. Duggan	Stenographer	1910, Feb. 4	800 00	
	F. R. Dunlop	do	1912, Dec. 17	725 00	
	B. McDonald	do	1911, Mar. 30	800 00	
Record Branch	S. K. Burdin	Chief Clerk	1916, Apr. 6	2,400 00	
	C. Dies	Clerk	1907, Mar. 13	1,350 00	
	A. P. Saunders	do	1913, Apr. 30	1,100 00	
	C. W. St. John	do	1910, Apr. 14	1,100 00	
	A. Ferguson	do	1916, Apr. 6	1,100 00	
	W. B. Baines	do	1912, Oct. 5	1,050 00	
	F. Samuels	do	1909, Mar. 24	1,025 00	
	H. Brophy	Mailing Clerk	1898, Oct. 1	1,000 00	
Bureau of Mines	T. W. Gibson	Deputy Minister	1891, June 19	4,200 00	
	R. D. Fisher	Secretary	1907, Mar. 13	1,600 00	
	D. H. Barr	Clerk	1907, Mar. 13	1,350 00	
	F. L. Godson	do	1915, June 18	1,000 00	
	W. Lemoine	do	1908, Apr. 8	1,250 00	
	Anne Moffatt	do	1901, Mar. 1	1,200 00	
	A. G. Scovell	do	1909, Mar. 24	1,250 00	
	Ethel Craig	Clerk and Stenographer	1906, May 16	800 00	Resigned April 30, 1917.
	F. McDougall	do do	1907, Mar. 13	800 00	Resigned July 28, 1917.
	J. L. McNaughton	do do	1909, Mar. 24	800 00	
	H. W. Batchelor	Stenographer	1911, Dec. 19	750 00	

D. GEO. ROSS,
Accountant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 2.

List of Agents for the year ending October 31st, 1917.

Name.	Post office address	District or County.	Date of appointment.	Salary per annum.	Remarks.
		Land Agents.		$ c.	
Anderson, T. V.	Hearst	Part District of Algoma	1913, May 9	600 00	
Arthurs, E.	Espanola Mills	do do do	1915, May 7	200 00	
Baker, R. H.	Minden	Part of Victoria	1907, Oct. 1	350 00	
Bolger, J. W.	New Liskeard	Lake Temiskaming, District of Nipissing	1913, July 17	900 00	
Both, C.	Denbigh	Part of Frontenac and Addington	1905, Oct. 20	200 00	
Brown, John	Markstay	Part of District of Nipissing and Sudbury	1916, June 27	500 00	
Brown, J. B.	Bracebridge	Muskoka District	1905, July 28		For salary see Homestead Inspectors.
Burrows, W. A.	Port Arthur	Part District of Thunder Bay	1912, Jan. 30	1,000 00	
Cameron, W.	Stratton Station	do do Rainy River	1911, April 27	500 00	
Campbell, I. M.	Parry Sound	do do Parry Sound	1914, Nov. 12	500 00	
Dempsay, S. J.	Cochrane	do do Nipissing	1911, Feb. 9	1,000 00	
Dodds, T.	Thessalon	do do Algoma	1915, May 4	500 00	
Douglas, W. J.	Maynooth	do Hastings	1912, June 12	500 00	
Ellis, H. J.	Powassan	do District of Parry Sound	1909, May 21	500 00	
Flesher, H. H.	Massey	do do Sudbury	1916, May 3	500 00	Resigned June 30th, 1917.
Freeborn, Dr. J. S.	Magnetawan	do do Parry Sound	1905, Nov. 10	500 00	
Gibson, J. E.	Dryden	District of Rainy River	1914, Nov. 20	600 00	
Ginn, F. E.	Matheson	Part District of Nipissing	1912, Mar. 20	800 00	
Hales, W.	Apsley	do County of Peterborough	1911, July 20	250 00	
Hollands, C. J.	Fort Frances	do Townplot of Alberta and part District of Rainy River	1892, Oct. 12	300 00	
Jenkin, W.	Emsdale	do District of Parry Sound	1908, July 29	500 00	
McFayden, A.	Emo	do do Rainy River	1905, Sept. 8	500 00	
MacLennan, J. K.	Sudbury	do do Sudbury	1905, July 3	700 00	
Noble, E.	Sault Ste. Marie	do do Algoma	1913, Feb. 1	300 00	
Parsons, W. J.	North Bay	do do Nipissing	1908, April 8	600 00	
Philion, J. A.	Sturgeon Falls	do do do	1907, Sept. 13	500 00	
Prince, A.	Wilno	do of Renfrew	1905, July 12	500 00	
Small, R.	Mattawa	do District of Nipissing	1910, June 30	500 00	
Spry, W. L.	Kenora	do do Rainy River	1909, Sept. 21	600 00	Also Mining Recorder.
Teasdale, R. A.	Massey	do do Sudbury	1917, July 1	500 00	
Watt, F.	Pembroke	Part of Renfrew	1913, May 28	300 00	

Appendix No. 2.—Continued.

List of Agents for the year ending October 31st, 1917.

Name.	Post office address	District or County.	Date of appointment.	Salary per annum.	Remarks.
		Land Agents.—Concluded.		$ c.	
Whybourne, W. E.	Marksville	Part of St. Joseph Island	1905, April 7	300 00	
Wilson, A. N.	Kinmount	Part of Peterborough	1915, June 1	175 00	
Woollings, J.	Englehart	Part of District of Nipissing	1908, June 30	700 00	
		Homestead Inspectors.			
Barr, J.	Fort Frances	District of Rainy River	1906, Nov. 23	1,200 00	
Bastien, J. A.	Chelmsford	W. part of Sudbury District	1913, May 2	900 00	
Brown, J. B.	Bracebridge	Muskoka District	1905, July 28	1,000 00	Also Crown Land Agent.
Burnes, C. W.	South River	Parry Sound District	1905, Nov. 15	1,000 00	
Cragg, W. V.	New Liskeard	S. part of Temiskaming District	1913, Mar. 27	1,200 00	
Dean, T.	Sault Ste. Marie	Algoma District	1908, July 29	800 00	
Hughes, T.	Murillo	Thunder Bay District	1908, July 20	1,000 00	
Poole, E. G.	Porquis Jct.	Part Temiskaming District	1916, Sept. 12	1,200 00	Resigned January 30th, 1917.
Quenneville, I.	Sturgeon Falls	E. part Sudbury and W. part Algoma Districts	1906, May 7	900 00	
Smith, D.	Cochrane	N. part Temiskaming District	1912, April 16	1,500 00	
Watson, T. P.	Englehart	Centre part of Temiskaming District	1905, May 10	1,200 00	
Wigle, R. G.	Dryden	Kenora District	1914, May 27	1,200 00	
		Timber Agents.			
Bremner, G.	Cochrane	Part Temiskaming and Algoma Districts	1913, May 20	1,800 00	
Christie, W. P.	Parry Sound	Part Parry Sound and Muskoka Districts	1903, Dec. 4	1,600 00	
Darby, E. J.	Ottawa	Part Ottawa District	1889, July 26	1,500 00	
Hawkins, S J.	Webbwood	Part Algoma and Sudbury Districts	1905, Aug. 16	1,500 00	
Henderson, C.	Sudbury	do do	1902, Jan. 1	2,000 00	
Huckson, A. H.	Sault Ste. Marie	Part District of Algoma	1914, April 1	1,600 00	
Johnson, S. M.	Arnprior	Part Ottawa and Parry Sound Districts	1907, Jan. 11	1,600 00	
MacDonald, S. C.	New Liskeard	Part Temiskaming District	1907, June 21	1,700 00	
Margach, W.	Kenora	Kenora District	1889, May 16	1,600 00	
McDonald, H.	Thessalon	Part District of Algoma	1905, April 20	1,500 00	
McDougall, J. T.	North Bay	Nipissing and part Sudbury District	1908, July 8	1,700 00	

Oliver, J. A.	Port Arthur	Thunder Bay District	1905, Sept.	30	1,700 00	
Stevenson, A.	Peterborough	Belleville	1905, Oct.	4	1,500 00	
Watts, Geo.	Fort Frances	Rainy River District	1910, April	19	1,500 00	
Wood, W. G. A.	Porcupine	Porcupine District	1917, Feb.	28	1,200 00	
		Mining Recorders.				
Browning, A. J.	Elk Lake	Montreal River Mining Division	1913, July	15	1,100 00	
Campbell, C. A.	Sudbury	Sudbury Mining Division	1910, Jan.	6	900 00	
Gauthier, G. H.	Porcupine	Porcupine Mining Division	1912, July	16	1,500 00	
Hough, J. A.	Matheson	Larder Lake Mining Division	1907, May	22	1,200 00	
Miller, N.	Sault Ste. Marie	Sault Ste. Marie Mining Division	1915, June	9	1,000 00	
Morgan, J. W.	Port Arthur	Port Arthur Mining Division	1906, Dec.	28	1,000 00	
Morgan, M. R	Tashota	Kowkash Mining Division	1916, Mar.	10	900 00	
McAulay, N. J.	Haileybury	Temiskaming Mining Division	1915, May	8	1,800 00	
McQuire, H. F.	Parry Sound	Parry Sound Mining Division	1906, Sept.	26	500 0	
Sheppard, H. E.	Elk Lake	Gowganda Mining Division	1909, Feb.	10	1,000 00	
Skill, A.	Elk Lake	Montreal River Mining Division	1909, April	1	1,200 00	Killed in action, October 29th, 1917.
Spry, W. L.	Kenora	Kenora Mining Divison	1909, Sept.	21	750 0(	
		Emigration Agents.				
Reid, R.	London	England	1913, Feb.	7	5,000 00	
Clark, J. M.	London	do	1913, Mar.	17	1,800 00	

D. GEO. ROSS,
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ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 3.

Statement of Lands Sold and Leased. Amount of Sales and Leases and Amount of Collections for the year ending October 31st, 1917.

Service.	Acres sold and leased.	Amount of sales and leases.	Collection on sales and leases.
Lands Sold:		$ c.	$ c.
Agricultural and Townsites	109,303.53	78,105 76	63.079 87
Mining	20,154.31	52,985 64	57,054 50
Clergy Lands	....	....	976 78
Common School Lands	....	....	3,333 59
Grammar School Lands	....	....	963 86
University Lands	2,074.73	1,802 37	2,598 91
Lands Leased:			
Mining	4,962.29	4,722 44	16,884 67
Crown	29,068.88	3,245 09	62,845 01
Temagami	64.32	87 00	814 50
	165,628.06	140,948 30	208,551 69

D. GEO. ROSS,
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ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 4.

Statement of Revenue of the Department of Lands, Forests and Mines for the year ending October 31st, 1917.

Service.	$ c.	$ c.	$ c.
Land Collections.			
Crown Lands:			
Agricultural	58,353 25		
Townsites	4,726 62		
		63,079 87	
Mining Sales	....	57,054 50	
Clergy Lands	976 78		
Common School Lands	3,333 59		
Grammar School Lands	963 86		
University Lands	2,598 91		
		7,873 14	
Rent:			
Mining Leases	16,884 67		
Crown Leases	62,845 01		
Temagami Leases	814 50		
		80,544 18	
Miners' Licenses	26,732 97		
Permits	850 00		
Recording Fees	34,673 44		
		62,256 41	
Supplementary Revenue:			
Acreage Tax	14,347 99		
Profit Tax	1,503,967 62		
Gas Tax	39,227 76		
		1,557,543 37	
			1,828,351 47
Woods and Forests.			
Bonus	....	640,835 35	
Timber Dues	....	832,467 24	
Ground Rent	....	100,408 33	
Transfer Fees	....	6,665 10	
Fire Protection	....	115,327 06	
			1,695,703 08
Provincial Assay Fees	726 52		
Casual Fees	1,760 89		
Cullers' Fees	112 00		
Forest Reserves Guides' Fees	161 00		
Algonquin Provincial Park	5,615 33		
Quetico Provincial Park	73 00		
		5,688 33	
			8,448 74
Refunds.			
Fire Ranging	....	24,486 35	
Wood Ranging	....	19,184 93	
Algonquin Park Cleaning Right-of-Way	....	2,549 60	
Colonization	....	274 87	
Agents' Salaries	....	105 00	
Contingencies	....	60 52	
Mines and Mining	....	27 50	
Bureau of Mines	....	4 00	
			46,692 77
			3,579,196 06

D. GEO. ROSS,
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ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 5.

Statement of Receipts of the Department of Lands, Forests and Mines for the year ending October 31st, 1917, which are considered as Special Funds.

Service.	$ c.	$ c.
Clergy Lands.		
Principal	413 45	
Interest	563 33	
		976 78
Common School Lands.		
Principal	1,771 35	
Interest	1,562 24	
		3,333 59
Grammer School Lands.		
Principal	540 96	
Interest	422 90	
		963 86
University Lands.		
Principal	2,233 40	
Interest	365 51	
		2,598 91
		$7,873 14

D. GEO. ROSS,
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Appendix No. 6.

Statement of Disbursements of the Department of Lands, Forests and Mines for the year ending October 31st, 1917.

Service.	$ c.	$ c.	$ c.
AGENTS' SALARIES AND DISBURSEMENTS.			
Land, $16,861.54.			
Anderson, T. V.	550 00		
Disbursements	21 00		
		571 00	
Arthurs, E.		200 00	
Baker, R. H.	350 00		
Disbursements	6 59		
		356 59	
Bolger, J. W.	800 00		
Disbursements	42 09		
		842 09	
Both, C.		200 00	
Brown, John	500 00		
Disbursements	4 12		
		504 12	
Burrows, W. A.	850 00		
Disbursements	323 35		
		1,173 35	
Cameron, W.	500 00		
Disbursements	37 00		
		537 00	
Campbell, Miss I. M.	500 00		
Disbursements	15 00		
		515 00	
Dempsay, S. J.	800 00		
Disbursements	96 00		
		896 00	
Dodds, T.	400 00		
Disbursements	15 00		
		415 00	
Douglas, W. J.	500 00		
Disbursements	36 46		
		536 46	
Ellis, H. J.		500 00	
Flesher, H. H.		332 00	
Freeborn, J. S.	500 00		
Disbursements	14 70		
		514 70	
Gibson, J. E.	516 60		
Disbursements	165 15		
		681 75	
Ginn, F. E.	700 00		
Disbursements	222 99		
		922 99	
Hales, W.		250 00	
Hollands, C. J.		300 00	
Jenkin, W.	500 00		
Disbursements	8 35		
		508 35	
Carried forward		10,756 40	

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		10,756 40	
AGENTS' SALARIES AND DISBURSEMENTS.—*Continued*			
Land.—Concluded.			
McFayden, A.	500 00		
Disbursements	42 25		
		542 25	
MacLennan, J. K.		600 00	
Noble, E.		300 00	
Parsons, W. J.	550 00		
Disbursements	24 00		
		574 00	
Philion, J. A.	500 00		
Disbursements	22 32		
		522 32	
Prince, A.	500 00		
Disbursements	22 00		
		522 00	
Small, R.	500 00		
Disbursements	23 00		
		523 00	
Spry, W. L.	500 00		
Disbursements	393 40		
		893 40	
Teasdale, R. A.		167 67	
Watt, F.		300 00	
Whybourne, W. E.	275 00		
Disbursements	3 50		
		278 50	
Wilson, A. N.	175 00		
Disbursements	13 00		
		188 00	
Woollings, J.	650 00		
Disbursements	44 00		
		694 00	
Homestead Inspectors, $16,383.25.			
Barr, J.	1,200 00		
Disbursements	1,095 90		
		2,295 90	
Bastien, J. A.	750 00		
Disbursements	261 66		
		1,011 66	
Brown, J. B.	1,000 00		
Disbursements	236 65		
		1,236 65	
Burnes, C. W.	950 00		
Disbursements	257 99		
		1,207 99	
Cragg, W. V.	1,200 00		
Disbursements	201 65		
		1,401 65	
Dean, T.	700 00		
Disbursements	82 10		
		782 10	
Carried forward		24,797 49	

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	24,797 49	
AGENTS' SALARIES AND DISBURSEMENTS.—*Continued*			
Homestead Inspectors.—Concluded.			
Hughes, T.	900 00		
Disbursements	609 10		
		1,509 10	
Poole, E. G.	....	300 00	
Quenneville, I.	725 00		
Disbursements	459 45		
		1,184 45	
Smith, D.	1,250 00		
Disbursements	886 15		
		2,136 15	
Watson, T. P.	1,100 00		
Disbursements	486 90		
		1,586 90	
Wigle, R. G.	1,100 00		
Disbursements	580 70		
		1,680 70	
Timber, $32,040.62.			
Bremner, G.	1,499 59		
Disbursements	604 10		
		2,103 69	
Christie, W. P.	1,600 00		
Disbursements	241 71		
		1,841 71	
Hawkins, S. J.	1,500 00		
Disbursements	417 54		
		1,917 54	
Henderson, C.	1,900 00		
Webster, W. A., Assistant	961 00		
Disbursements	399 00		
		3,260 00	
Huckson, A. H.	1,512 00		
Disbursements	222 50		
		1,734 50	
Johnson, S. M.	1,600 00		
Disbursements	131 11		
		1,731 11	
MacDonald, S. C.	1,608 33		
Disbursements	315 83		
		1,924 16	
Margach, W.	1,600 00		
Legris, J., Assistant	1,442 00		
Cunningham, E. A., Stenographer	379 50		
Disbursements	1,265 04		
		4,686 54	
McDonald, H.	1,500 00		
Disbursements	314 97		
		1,814 97	
McDougall, J. T.	1,650 00		
Disbursements	434 93		
		2,084 93	
Oliver, J. A.	1,600 00		
Kytoma, M., Stenographer	436 52		
Porter, M., Stenographer	89 99		
Disbursements	682 45		
		2,808 96	
Carried forward	....	59,102 90	

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		59,102 90	
AGENTS' SALARIES AND DISBURSEMENTS.—*Concluded*			
Timber.—Concluded.			
Stevenson, A.	1,500 00		
Disbursements	471 16		
		1,971 16	
Watt, G.	1,500 00		
McDonald, A., Assistant	1,338 10		
Disbursements	263 25		
		3,101 35	
Wood, W. G. A.	800 00		
Disbursements	260 00		
		1,060 00	
Miscellaneous, $1,437.10.			
Bilton, G., Caretaker Islands in North and South Crosby		25 00	
Guthrie, W., Caretaker Islands in Devil Lake		50 00	
Jamieson, W. K., Caretaker Islands in Dog and Laboria Lakes		50 00	
McArthur, T. A., Inspector of Agencies	675 00		
Disbursements	637 10		
		1,312 10	66,672 51
OTTAWA AGENCY.			
Darby, E. J., Agent		1,500 00	
Larose, S. C., Clerk		1,000 00	
Rent	700 00		
Disbursements	86 25		
		786 25	3,286 25
WOOD RANGING.			
Acheson, Ira M.		1,235 00	
Allen, R. A.		705 00	
Arnill, Wm.		1,135 00	
Bailey, Alex.		895 00	
Barrett, Thos.		905 50	
Bates, R.		600 00	
Beaton, C.		445 00	
Bichord, L.		382 50	
Bliss, L. E.	395 00		
Disbursements	45 13		
		440 13	
Bonhome, S.		193 50	
Bouchard, J.		57 00	
Breman, C.		399 00	
Bromley, T. A.		755 00	
Brown, J. A.		461 00	
Brooks, W. J.		835 00	
Buchan, S.		114 00	
Buchanan, R.		765 00	
Buisson, Wm.		365 00	
Cameron, John K.	205 00		
Disbursements	17 10		
		222 10	
Carbeil, S.		307 50	
Castonguay, A. C.		1,020 00	
Charlebois, P.		1,014 00	
Chenier, D. A.		1,608 50	
Chenier, G. T.		360 00	
Clairmont, E.		508 00	
Clapson, H.		108 75	
Carried forward		15,836 48	69,958 76

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		15,836 48	69,958 76
WOOD RANGING.—*Continued.*			
Clarke, W. R.		38 50	
Close, R. J.		667 25	
Cloud, Wm.		177 00	
Connelly, Dan		1,565 00	
Comer, B. F.		544 00	
Corrigan, R. T.		1,100 00	
Cowchroski, A.		292 50	
Coyne, P.		750 00	
Cross, R. J.		516 00	
Crowley, C.		42 00	
Dawkins, J. J.		44 00	
Dennie, F. J.		450 00	
Dickson, C.		57 00	
Didier, H.		740 00	
Doxse, J. E.		1,070 00	
Dunn, Wm.		78 75	
Dunn, J. F.		705 00	
Durrell, Wm.		945 00	
Duval, C. A.		410 00	
Dyson, I.		159 00	
Eakins, W.		66 00	
Eaton, James		240 00	
Eldridge, R.		448 00	
Emlaw, O.		900 00	
Emond, A.		348 00	
Fairburn, N. H.		755 00	
Ferguson, E. A.		835 00	
Fisher, Geo.		770 00	
Fitzback, J.		207 00	
Fletcher, N.		715 00	
Foster, W. G.		384 00	
Fraser, D.		260 00	
Fraser, W. A.		645 00	
Frechette, O.		42 00	
Ganton, D.		715 00	
Gardner, Wm.		408 00	
Gill, Chas.		480 00	
Hagan, E. G.		885 50	
Haines, B.		504 75	
Hamilton, R.		189 00	
Hart, Isaac		658 00	
Hartley, Chas.	1,177 50		
Disbursements	3 50		
		1,181 00	
Harvey, J.		42 00	
Hauralty, P.		742 25	
Hawkins, Wm.		424 00	
Henderson, Chas. .... Disbursements		508 07	
Henderson, John		61 75	
Henderson, A. E.		1,165 00	
Henderson, L. E.		1,195 00	
Hey, Ben		480 00	
Hoff, J. S. M.		829 50	
Hornick, Geo.		57 00	
Huckson, A. H. .... Disbursements		1,086 95	
Huckson, E.		979 50	
Hurdman, W. H.		775 00	
Hutton, John		1,130 00	
Jamieson, J.		544 00	
Carried forward		47,843 75	69,958 76

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		47,843 95	69,958 76
WOOD RANGING.—*Continued.*			
Jeroux, A.		140 00	
Johnsor, C.		423 75	
Jones, W.		452 00	
Kernahan, G. A.		528 00	
King, Sam		195 00	
Labree, Paul		502 50	
Laframbois, E.		236 00	
Lamon, Wm.		745 75	
Lapointe, Jas.		72 00	
Lee, J. B.		765 00	
Lepage, L.		623 25	
Leishman, E.		722 50	
Leroy, L. H.		519 50	
Lilevre, Joe		399 00	
Linklater, Geo.		1,209 50	
Little, T.		528 00	
Long, H. E.	480 00		
Disbursements	37 51		
		517 51	
Lowe, Wm.		252 00	
MacDonald, S. C. Disbursements		15 90	
Macdonnell, R. D.		680 00	
Mahoney, Thos.		82 50	
Manice, Wm.		1,177 50	
Margach, J. A.		810 00	
Margach, Wm. Disbursements		3,004 83	
Marr, H. S.	572 00		
Disbursements	2 30		
		574 30	
Maughan, Jos. Disbursements		30 70	
Menzies, Alex.	1,698 50		
Disbursements	139 02		
		1,837 52	
Mercier, Ed.		329 25	
Miller, J. A.		120 00	
Milway, J. H.		704 75	
Minty, A.		131 25	
Molyneaux, Geo.		650 00	
Moody, L.		850 00	
Mooney, L.	1,580 50		
Disbursements	248 18		
		1,828 68	
Moore, Joseph		36 00	
Moran, A.		1,430 00	
Morel, A.		452 50	
Morel, H.		704 00	
Murray, John		677 00	
Murray, Earl		48 75	
Murray, James		155 25	
Murray, Thos.		855 50	
Murray, Wm.		1,295 00	
McAulay, W. D.		665 00	
McCaw, J. G.	1,430 00		
Disbursements	8 55		
		1,438 55	
McCaw, J. E.		950 00	
McCuaig, J. A.		172 50	
McCuaig, R.		137 75	
McDonald, T.		800 00	
McDonald, J D.		1,430 00	
McDonald, Hector Disbursements		15 00	
Carried forward		80,764 99	69,958 76

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		80,764 99	69,958 76
WOOD RANGING.—*Continued.*			
McDougall, J. T. ..... Disbursements		94 63	
McFarlane, J. A.		131 25	
McFarlane, A.		126 50	
McGillivray, D. D.		412 00	
McGregor, Wm.		4 00	
McGuire, P.		276 00	
McGuire, C.		525 00	
McIvor, J. A.		1,144 00	
McKee, Wm.		258 75	
McKendry, W. B.		750 00	
McLay, A.		240 00	
McLaughlin, John		343 50	
McLean, John	1,470 00		
Disbursements	147 05		
		1,617 05	
McManemun, C.		11 50	
McNabb, Alex.		885 00	
McPherson, J. S.		1,430 00	
Naponse, M.		292 50	
Nault, J.		504 00	
Nepham, D.		399 00	
Nelson, P.		214 50	
Niblet, James		1,250 00	
Nicoll, Geo.		7 50	
Nolan, H.		138 75	
Oliver, J. A. ..... Disbursements		178 31	
Paulen, C.		140 00	
Peiton, F.		166 75	
Pigott, John		505 00	
Rae, A.		57 00	
Reid, John		900 00	
Ridley, R.		1,260 00	
Ritchie, John F.		820 00	
Ross, Sidney		1,242 75	
Ryan, James		488 00	
Shaw, Alfred		957 50	
Shaw, D.		544 00	
Sharp, James		675 00	
Shewfelt, Alfred		168 75	
Short, J.		560 00	
Simpson, Wm.		1,430 00	
Smith, Geo.		166 25	
Smith, J. D. C.		592 00	
Snyder, F.		435 75	
Spavin, John		765 00	
Spence, D.		1,578 50	
Spofford, Thos.		565 50	
Squires, J.		142 50	
Stein, P.	1,129 25		
Disbursements	35 37		
		1,164 62	
Stewart, D.	1,405 00		
Disbursements	40 35		
		1,445 35	
Stewart, T. F.		412 00	
Talouse, B.		3 00	
Thompson, W. B.		1,195 00	
Tichborne, H. C.		460 00	
Urquhart, A.		775 00	
Vanderberg, N.		829 00	
Vanslyke, J.		565 25	
Carried forward		113,008 20	69,958 76

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		113,008 20	69,958 76
Wood Ranging.—*Concluded.*			
Vincent, H. T.		1,030 00	
Washburn, J.		171 00	
Watts, Fred.		480 00	
Webster, W. A. ... Disbursements		71 25	
Whelan, P. J.		1,430 00	
Willan, Wm.		345 00	
Wilson, D.		840 00	
Wilson, C.		159 00	
Windle, James		471 50	
Wylie, B. M.		60 00	
Yeomans, James		1,276 50	
Young, J. J.		99 75	
Young, R. J.		710 00	
			120,152 20
Fire Ranging.			
Abraham, Mike		57 50	
Abrey, Joseph		300 00	
Adair, R. A.		71 50	
Adams, Alex.		335 00	
Agnew, Wm.		270 00	
Alcock, F.		147 50	
Allen, R. A.		840 00	
Allen, Wm.		22 50	
Amelonap, J.		16 25	
American Tent and Awning Co. ... Supplies		220 35	
Anderson, M.		302 50	
Armstrong, B.		252 00	
Armstrong, W. H.		345 00	
Archambault, G.		374 00	
Ashby, L.		320 00	
Atkins, C.		330 00	
Atkinson, B.		312 50	
Bailey, H.		453 75	
Baonatos, M.		237 50	
Barrie, T.		376 75	
Barry, C.		305 00	
Bartlett, Geo. W. ... Disbursements		41 50	
Bartrand, I.		257 50	
Bates, R.		352 00	
Bayne, J. O.		387 50	
Beach, F. C.		217 50	
Beaudry, M.		317 50	
Beauvis, James		305 00	
Beauvis, P.		322 50	
Bedard, I.		347 50	
Bedford, H.		272 50	
Begley, Wm. P.	180 00		
Disbursements	20 57		
		200 57	
Behaniell, Geo.		325 00	
Belanger, B.		20 00	
Belcher, E. D.		330 00	
Bell, H.		156 75	
Bellefull, O.		365 00	
Belton, Wm. J.		347 50	
Benard, D.		471 00	
Benn, H. F.		345 00	
Berg, A.		205 00	
Bergeron, J.		260 00	
Berigan, S.		110 00	
Carried forward		11,846 42	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		11,846 42	190,110 96
FIRE RANGING.—*Continued.*			
Berigan, D.		110 00	
Berlinquette, J.		346 50	
Bevan, T. W.		315 00	
Bezeau, U.		212 50	
Bird, John		345 00	
Bishop, F.		287 50	
Bisson, A.		290 00	
Blair, Geo.		25 00	
Blake, H.		338 25	
Blanchett, O.		112 50	
Blaski, F.		322 50	
Bliss, L. E.	1,974 28		
Disbursements	2,712 22		
		4,686 50	
Boivin, J.		317 50	
Boland, Wm.		330 00	
Boldt, A.		345 00	
Bolger, P. W.		285 00	
Bolsley, Frank		150 00	
Bonhome, L.		290 00	
Bookout, H. B.		320 00	
Boorze, A.		182 50	
Boorze, R.		182 50	
Booth, J. R.		49 50	
Bossie, R.		40 00	
Both, Alfred		352 50	
Both, Albert		377 50	
Bottrell, D.		315 00	
Boucher, C.		357 50	
Boucher, S.		225 50	
Boucher, J.		92 50	
Bouchard, E.		142 50	
Bouchard, A.		127 50	
Boudat, F.		152 50	
Bourbonnais, A.		285 00	
Bourdegnon, F.		57 75	
Bowers, Geo.		330 00	
Bowins, John		17 50	
Bowland, J. J.	860 00		
Disbursements	943 28		
		1,803 28	
Bowman, Theo.		280 00	
Bowles, J.		332 50	
Boyce, B.		327 25	
Boyd, John		347 50	
Boyd, J. F.		282 50	
Boys, John		290 00	
Bradley, W. E.		280 00	
Bradley, J.		324 50	
Branconnier, J.		120 00	
Brazzel, Robt.		230 00	
Breen, Geo.		322 50	
Brennan, Guy		190 00	
Brennan, G.		255 00	
Brennan, R. L.		357 50	
Bromley, E. H.		342 50	
Bromley, C.		231 00	
Brooks, W.		320 00	
Brown, John		307 50	
Brown, T. E.		337 50	
Carried forward		31,843 95	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		31,843 95	190,110 96
FIRE RANGING.—*Continued.*			
Brown, Aug.		312 50	
Brown, Thos.		195 00	
Brown, Geo.		352 00	
Brown, H.		280 00	
Brownlee, J. J.		24 75	
Bruce, John		282 50	
Brum, A. W.	805 00		
Disbursements	165 15		
		970 15	
Buckingham, Geo.		343 25	
Bunting, H. T.		320 00	
Burgess, R.		235 00	
Burk, John		340 00	
Burk, T.		7 50	
Burkman, C.		382 50	
Burleigh, J.		305 00	
Burns, J.		295 25	
Burnes, Fred.		292 50	
Bruette, F.		97 50	
Byrne, H.		22 50	
Byrne, J.		245 00	
Byrnes, J.		257 50	
Cadere, H.		387 50	
Cahill, B.		327 50	
Calderwood, S.		115 00	
Caldwell, C.		277 50	
Cameron, N. A.		322 50	
Cameron, W. H.		302 50	
Cameron, Geo.		100 00	
Campbell, W. A.		462 00	
Campbell, R. A.		345 50	
Campbell, T. J.		345 00	
Campbell, A.		310 00	
Campbell, T. S.		176 00	
Campbell, D.		345 00	
Campbell, Wm.		572 00	
Campbell, Geo.		312 50	
Campbell, Ira		180 00	
Campbell, S.		127 50	
Campbell, Wesley		187 50	
Canore, Joseph		220 00	
Canton, C.		65 00	
Carmichael, T.		350 00	
Carnochan, Geo.		367 50	
Carrier, C.		165 00	
Carson, S.		122 50	
Case, Geo.		325 00	
Caslick, Wm.		217 50	
Caswell, G.		192 50	
Caswell, Ed.		382 50	
Caswell, R.		350 00	
Causley, N.		362 50	
Cellery, A.		82 50	
Chaffey, Wm.		360 00	
Chamberlain, H.		302 50	
Chapman, C. N.		300 00	
Charette, N.		237 50	
Charette, S.		307 50	
Carried forward		47,309 85	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		47,309 85	190,110 96
FIRE RANGING.—*Continued.*			
Charron, J.		375 00	
Chase, J.		270 00	
Chenier, R.		142 50	
Chenier, G. T.		148 50	
Chief, T.		150 00	
Chief, J.		130 00	
Child, H.		245 00	
Christie, W. P. Disbursements		467 54	
Church, I.		5 00	
Clairmont, H.		367 50	
Clark, W. R.	405 00		
Disbursements	967 59		
		1,372 59	
Clark, H.		349 25	
Clery, J.		321 75	
Clegg, R.		315 00	
Cliff, W.		277 50	
Coady Bros. Equipment		500 00	
Cochrane, H. D.		347 50	
Coghlan, Thos.		387 50	
Coghlan, J. S.		325 00	
Coleman, E. J.		267 50	
Coleman, D.		147 50	
Commerand, Joe		290 00	
Connell, Wm.		451 00	
Conroy, Ed.		280 00	
Conway, R.		390 00	
Cook, E.		352 50	
Cook, Wm.		72 50	
Cooke, Wm.		210 00	
Cooper, Thos.		572 00	
Costello, H.		222 50	
Costello, H.		332 50	
Cotie, Fred		215 00	
Cottam, J. T.		275 00	
Cotte, H.		231 00	
Cottenham, W.		390 00	
Cox, Jos.		367 50	
Coyne, P.	765 00		
Disbursements	172 07		
		937 07	
Craig, John		327 50	
Cramorday, J.		16 25	
Crateau, C.		275 00	
Creswick, H. H.		320 00	
Critchley, P.	26 25		
Disbursements	5 00		
		31 25	
Crosbie, W. J.		312 50	
Cryderman, N.		56 00	
Culhane, John	392 50		
Disbursements	49 26		
		441 76	
Culhane, A.		282 50	
Culhane, D.		220 00	
Cullen, M. T.		510 50	
Cullen, W. F.		253 00	
Cullin, A. E.		265 00	
Carried forward		63,121 81	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		63,121 81	190,110 96
FIRE RANGING.—*Continued.*			
Cunoy, R.		231 00	
Currie, F.		72 00	
Curtin, D.		347 50	
Curtis, John		357 50	
Dagg, A.		332 50	
Dagnis, E.		82 50	
Dambremont, F.		230 00	
Dane, Alfred		347 50	
Darby, Wm.		572 00	
Davidson, J.		99 00	
Davidson, John		332 50	
Davis, Thos.		302 50	
Dawe, Wm.	129 00		
Disbursements	21 60		
		150 60	
Dawkins, J. J.		377 50	
Dean, A.		317 50	
Dear, A.		67 50	
Dennie, M.		257 50	
Dennie, F. J.	905 00		
Disbursements	186 01		
		1,091 01	
Dennison, H.		387 50	
Derocher, S.		170 00	
Dischamp, F.		320 00	
Desjardine, F.		357 50	
Deslauriers, E.		255 00	
Dessermean, J.		195 00	
Dickson, R. N.		320 00	
Dimond, P.		100 00	
Dobie, Thos.		127 50	
Dodds, G.		325 00	
Dodds, W. H.		354 75	
Dodds, Thos.		357 50	
Donaldson, C.		347 50	
Donta, Jos.		347 50	
Douchime, S.		165 00	
Douchime, D.		162 50	
Douglas, J. R.		342 50	
Dourin, James		260 00	
Dowd, H. L.		346 50	
Dowdall, D.		112 50	
Doyle, James		342 50	
Dube, F.		305 00	
Dubois, A. L.		307 50	
Duke, D.		212 50	
Dulmage, J.		20 00	
Dunbar, James		322 50	
Dunn, J. O.		280 00	
Dupine, H.		397 50	
Dupuis, E.		357 50	
Duquette, H.		317 50	
Durnin, C.	160 00		
Disbursements	9 00		
		169 00	
Durocher, F.		90 00	
Durrell, John		165 00	
Durrell, D.		295 00	
Carried forward		77,625 17	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		77,625 17	190,110 96
FIRE RANGING.—*Continued.*			
Durrell, L.		148 00	
Dusang, A.		556 50	
Duval, C. A. Disbursements.		22 19	
Edwards, J. K.		305 00	
Elliott, W. J.		360 00	
Elliott, Jackson		327 50	
Elliott, Frank	612 00		
Disbursements	23 20		
		635 20	
Elliott, Wm.		302 50	
Elliott, C. H.		325 00	
Ellis, E. C.		337 50	
Ellsworth, C. B.		320 00	
Emes, H.		382 50	
Evans, W. J.	995 00		
Disbursements	1,525 65		
		2,520 65	
Fahey, R.		283 75	
Fairburn, N.		52 50	
Fairman, Wm.		14 00	
Favell, F.		65 00	
Favreau, Geo.		342 50	
Ferguson, T. H.	588 00		
Disbursements	3 32		
		591 32	
Ferguson, Frank		342 50	
Ferguson, A.		345 50	
Ferguson, J. R.		150 00	
Ferguson, Geo.		342 50	
Ferris, R.		88 00	
Fillion, D.		147 50	
Findlay, James		217 50	
Finlayson, H.		246 75	
Finlayson, N.		290 00	
Finlayson, J. H.		390 00	
Fisher, Geo.		765 00	
Fitzgerald, James		322 50	
Fitzpatrick, E.		157 50	
Flack, A.		319 00	
Flaherty, John		347 50	
Fletcher, N. B.	528 00		
Disbursements	41 35		
		569 35	
Flynn, J.		126 50	
Foard, F.		212 50	
Fontaine, M.		302 50	
Ford Motor Co. Trucks.		2,445 00	
Forman, A.		337 50	
Fortin, J. F.		242 50	
Foster, H.		213 50	
Foulle, W. J.		265 00	
Fox, J.		374 00	
Foy, Wm.		260 00	
Foy, E.		50 00	
Francois, J.		390 00	
Fraser, Ben		347 50	
Fraser, Peter		342 50	
Fraser, W. A.		367 50	
Carried forward		96,834 38	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		96,834 38	190,110 96
FIRE RANGING.—*Continued.*			
Fraser, Gordon		342 50	
Frechett, Bap.		357 50	
Frenette, L.		87 50	
Fritchett, O.		277 50	
Furlong, J.		280 00	
Furlong, Wm.		382 50	
Gagne, F.	835 00		
Disbursements	555 73		
		1,390 73	
Gagnon, Paul		277 50	
Gagnon, Joe		198 00	
Gagnon, Alex.		340 00	
Gagnon, N.		387 50	
Gallow, J.		312 50	
Galvin, G.		302 50	
Gamble, J. M.		175 00	
Gamble, Wm. M.		317 50	
Gammond, Geo.		295 00	
Gardner, F.		257 50	
Garneaux, P.		45 00	
Garrow, J.		177 50	
Gartshore, M.		347 50	
Gaughier, E. P.		57 75	
Gault, J.		330 00	
Gault, R.		363 00	
Gauthier, P.		137 50	
Gauthier, Theo.		150 00	
Geddion, James		77 50	
Gemmill, John	805 00		
Disbursements	539 09		
		1,344 09	
Genereaux, S.		282 50	
Gervais, F. H.		335 00	
Gervais, Ferd.		335 00	
Gibbons, O.		349 25	
Gellanders, Geo.		160 00	
Gillon, Bert.		195 25	
Gillon, Roy		167 75	
Gilmour, T.		297 50	
Gleison, W.		150 00	
Glover, R.		145 00	
Godin, T. H.		120 00	
Godin, P.		130 00	
Godin, E.		320 00	
Godmanson, L.		310 00	
Gomme, P.		39 00	
Gongeon, A.		250 00	
Gordon, Alfred		357 50	
Gorman, D.		343 00	
Graham, J.		150 00	
Graham, James		354 75	
Grant, A.		180 00	
Grawberger, T. J.		322 50	
Grey, A. H.		305 00	
Grills, D.		264 00	
Groome, L.		357 50	
Groulx, Chas.		247 50	
Groulx, Joe		245 00	
Carried forward		112,658 45	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		112,658 45	190,110 96
FIRE RANGING.—*Continued.*			
Groulx, A., Sr.		345 00	
Groulx, A., Jr.		360 00	
Gudgeon, J.		52 50	
Guilbault, A. T.		320 00	
Gunn, H.		260 00	
Gunter, R. H.		367 50	
Gunter, J.		342 50	
Guthrie, Wm.		315 00	
Gutoskie, A.		92 50	
Hackenbruck, M.		280 00	
Hagan, C.		367 50	
Hagarty, Jerry		397 50	
Haldane, F.		315 00	
Haley, Ed.		347 50	
Hall, G.		262 50	
Hall, F.		147 50	
Hall, J.		192 50	
Hall, Thos.		345 75	
Halley, L.		257 50	
Halliday, J.		305 00	
Hamilton, J. R.		345 00	
Hamilton, James		322 50	
Hamilton, F.	785 00		
Disbursements	823 04		
		1,608 04	
Hamon, F.		342 50	
Hand, T.	880 00		
Disbursements	740 15		
		1,620 15	
Hanmer, J.		240 00	
Hannan, J. W.		105 00	
Hanrahan, D.	665 00		
Disbursements	905 70		
		1,570 70	
Hanson, L.		105 00	
Harney, S.		316 25	
Harris, C.		184 25	
Harrison, G.		285 00	
Harrison, W.		350 00	
Harrison, D.		317 50	
Harvie, A.		305 00	
Haskins, Wm.		312 50	
Haskins, J.		137 50	
Hass, G.		262 50	
Hass, G. J.		347 50	
Hastings, John		385 00	
Hatch, A. L.		105 00	
Hawkins, G. M.		55 00	
Hawley, P.		165 00	
Hayes, C.		257 50	
Hayes, S.		290 00	
Hazard, Geo.		120 00	
Hebert, J.		180 00	
Heggart, Chas.		345 00	
Henderson, J.		362 00	
Hennessey, B. E.		170 50	
Hennessey, M. J.		257 50	
Henson, W.		235 00	
Carried forward		130,336 09	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		130,336 09	190,110 96
Fire Ranging.—*Continued.*			
Herbert, J.		280 00	
Herron, A.		170 00	
Heslip, C.		375 00	
Hey, Ben		815 00	
Hickley, J. L.	493 00		
Disbursements	257 85		
		750 85	
Higgins, J. R.		245 00	
Hill, Chas.		57 50	
Hogan, J.		330 00	
Hogan, P.		335 00	
Holmes, G.		435 00	
Hooper, F. T.		127 50	
Hooper, W. A.		332 50	
Hopkins, R. D.		195 00	
Horne, J. M.		343 75	
Horner, Ed.		220 00	
Hornick, Geo.		352 50	
Huckson, A. H. ......Disbursements		99 76	
Hugham, J. M.		42 50	
Hume, O. B.		342 50	
Hunn, W.		357 50	
Hunter, Wm.		290 00	
Hunter, L.		262 50	
Hurdman, W. H.	705 00		
Disbursements	95 65		
		800 65	
Irwin, Thos.		317 50	
Isbister, J. A.		349 25	
Jackman, H.		27 00	
Jackson, J. E.		50 00	
Jacob, M.		72 50	
Jarvis, J.		324 50	
Jenkin, S.	718 50		
Disbursements	504 50		
		1,223 00	
Jenson, A.		80 00	
Jerrett, E. L.		337 50	
Jewell, James		272 50	
Jewell, F.		330 00	
Jewell, F.		335 00	
Jocko, P.		331 25	
Johnson, Wm.		451 00	
Johnson, A.		203 50	
Johnson, F.	320 00		
Disbursements	160 00		
		480 00	
Johnson, R.		3 50	
Johnson, G. S.		335 00	
Johnson, David		19 25	
Johnson, W.		142 50	
Johnston, John		367 50	
Johnston, T. J.		374 00	
Jolicoure, P.		214 50	
Jonas, A.		125 00	
Jones, C. E.		312 50	
Keeler, G. H.		285 00	
Keeley, C. A.		350 00	
Carried forward		145,609 35	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		145,609 35	190,110 96
FIRE RANGING.—*Continued.*			
Keller, D. F.		255 75	
Kelley, Robt.		366 50	
Kelly, T.		345 00	
Kelly, Geo.		315 00	
Kemp, Wm.		312 50	
Keenahan, M.		342 50	
Kennedy, Robt.		347 50	
Kennedy Hardware Co. ... Supplies		73 44	
Kenrvorst, W. H.		47 50	
Keon, M.		198 00	
Keon, T.		17 50	
Kerr, Robt.		488 00	
Kewais, Wm.		302 50	
Kewais, Jacob		317 50	
Kiley, M.		280 00	
King, A.		145 75	
King, Robert		382 50	
King's Printer ... Supplies		2,131 78	
Kingston, T. H.		382 50	
Kingston, T. J.		382 50	
Kipling, G.		242 00	
Kirby, John, Sr.		305 00	
Kirby, John, Jr.		347 50	
Kirkhane, Lawrence		162 50	
Kirton, Wm.		362 50	
Kistabish, Frank		280 00	
Kitchen, James		377 50	
Kitchen, J.		257 50	
Kowalski, Chas.		242 50	
Krock, L. A.		207 50	
Kunkel, Frank		258 00	
Labine, Emile		220 00	
Labine, John		332 50	
LaBrash, J.		272 50	
LaBrash, James		280 00	
Lachance, M.		142 50	
Laclaire, W.		162 50	
Laffin, Bert		78 00	
Lofquest, M.		345 00	
Lagrow, G. W.		337 50	
Laidlaw, H.		357 50	
Laird, L. A.		50 00	
Laird, Peter		347 50	
Lalonde, Fred.		330 25	
Lamb, Joe		77 50	
Lamieux, N.		87 50	
Lamourieux, A.		295 00	
Lance, F.		332 50	
Landry, Amer		87 50	
Landry, John		322 50	
Langford, Thos.		342 50	
Langtree, John		345 00	
Langevain, Wm.		122 50	
Laplante, B.		50 00	
LaRose, Louis		257 50	
Larouix, J.		242 50	
Carried forward		161,904 32	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		161,904 32	190,110 96
FIRE RANGING.—*Continued.*			
Larwell, O.		382 50	
Laundry, Peter		260 00	
Lavigne, A.		117 50	
Lavoie, X.		347 50	
Lawrence, S.		350 00	
Leblanc, O.	556 00		
Disbursements	52 40		
		608 40	
LeBlanc, J.		325 00	
LeClaire, H.		280 00	
Lee, E. J.		347 50	
Lee, J. C.	601 00		
Disbursements	137 63		
		738 63	
Lee, J. B.	800 00		
Disbursements	198 87		
		998 87	
Lefebure, J.		357 50	
Lefrany, D.		3 75	
Legg, S.		57 50	
Legris, Thos.		347 50	
Legris, J. ....Disbursements		6,365 14	
Legris, H. M.		345 00	
Lemieux, F.		87 50	
Leonard, T.		347 50	
Leroy, L.	860 00		
Disbursements	1,174 00		
		2,034 00	
Lerwill, R.		307 50	
Leslie, E.		18 00	
Leudolph, B. H.	150 00		
Disbursements	10 69		
		160 69	
Liddicotte, Thos. L.		450 50	
Lileore, J.		132 50	
Lilley, D.		50 00	
Lillico, A. L.		317 50	
Linch, M.		123 75	
Livingston, John		353 00	
Logambre, P.		220 00	
Looney, John		357 50	
Lortie, E.		24 75	
Lothian, D. R.		139 00	
Love, F.		272 50	
Lovering, J. E.		317 50	
Lonwes, R. G.		310 00	
Ludford, F.		252 00	
Ludgate, John		129 25	
Luke, A.		73 90	
Lumb, John		370 00	
Lumb, J. C.		272 50	
Lundy, M. F.		342 50	
Lupeen, J.		59 50	
Lyle, J.		125 00	
Lynch, John		183 00	
MacDonald, C.		77 50	
MacDonell, L. P.		350 00	
Macdonell, R. D.		765 00	
Carried forward		183,160 45	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		183,160 45	190,110 96
FIRE RANGING.—*Continued.*			
MacGregor, W. H.	890 00		
Disbursements	632 76		
		1,522 76	
Mackie, H.		283 25	
MacNeil, J. A.		342 50	
MacPhee, A. L.		110 00	
Martin, W.		60 75	
Magher, Geo.		302 50	
Mallon, J.		140 00	
Maloney, J.		182 50	
Marcourt, P.		255 00	
Margach, Wm. Disbursements		59 36	
Margach, J. A.		552 00	
Marsh, Ed.		340 00	
Martin, Ed.		357 50	
Martin, T.		302 50	
Martin, T.		357 50	
Martin, A. L.		340 00	
Mason, Geo.		382 50	
Mason, G.		202 50	
Matheson, R.		167 75	
Mattice, J. H.		270 00	
Mawhinney, G. S.		307 50	
May, H.	730 00		
Disbursements	40 25		
		770 25	
Merchant, John		357 50	
Merkley, J. C.		240 00	
Messervier, T.		255 00	
Mickelson, John		307 50	
Middlebrook, J. N.		302 50	
Millar, R.		320 00	
Millichamp, T.		177 50	
Mills, W. E.		345 00	
Milway, J. H.	830 00		
Disbursements	1,002 39		
		1,832 39	
Minker, T.		220 00	
Minnawasin, P.		250 25	
Mitchell, P.		370 00	
Mitter, M.		162 50	
Moffatt, J.		382 50	
Molyneaux, Geo.	805 00		
Disbursements	1,130 12		
		1,935 12	
Mongrain, C.		96 00	
Montgomery, R.		231 50	
Montgomery, W. R.		307 50	
Montreiul, E.		245 00	
Montreiul, L.		382 50	
Montreiul, J. J.		317 50	
Moir, A.		322 50	
Moody, H. C.		317 50	
Moore, R.		272 50	
Moore, S.		127 50	
Moore, A. S.		357 50	
Moore, J. V.		345 00	
Moore, P.		220 00	
Carried forward		201,769 33	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		201,769 33	190,110 96
FIRE RANGING.—*Continued.*			
Moorhead, R.		280 00	
Morel, H.		315 00	
Morgan, Geo.	584 00		
Disbursements	41 80		
		625 80	
Morgan, F.		315 00	
Morgan, C.		52 25	
Moriarty, M.		345 00	
Moriarty, E.		107 50	
Morin, J.		330 00	
Morin, J.		357 50	
Morin, J.		327 25	
Morin, J.		280 00	
Morriseau, F.		198 00	
Morrison, J.		69 00	
Morrison, J.		180 00	
Morrison, J.		312 50	
Morton, Geo.		322 50	
Mosse, H.		172 50	
Moxam, V. R.		60 00	
Mucklinberry, T.		380 00	
Mullin, W. R.		365 75	
Murphy, J.		345 00	
Murrach, P.		77 50	
Musquatish, H.		322 50	
McAdam, J.		390 00	
McArthur, Wm.		312 50	
McAulay, W. D.	855 00		
Disbursements	775 42		
		1,630 42	
McBain, R.		312 50	
McCann, L.		322 50	
McCaw, Wesley		347 50	
McCaskill, S.		299 25	
McClelland, D. W.		280 00	
McColl, H.		347 50	
McCool, J.		42 50	
McCormick, P.		335 50	
McCormick, T.		377 50	
McCoy, C. L.		267 50	
McCreight, A.		357 50	
McCrindle, I.		257 69	
McCullough, D. J.		230 00	
McCulloch, T.		235 00	
MCurrach, Jas.		305 00	
McDermid, A.		267 50	
McDermott, W. H.		77 50	
McDonald, H. ... Disbursements		1,281 47	
McDonald, Archie		52 50	
McDonald, Alex.		294 25	
McDonald, F.		305 00	
McDonald, F.		317 50	
McDonald, J.		308 00	
McDonald, T.		580 00	
McDonald, J. R.		279 50	
McDonald, D. R.		310 00	
McDonald, G.		99 00	
Carried forward		218,732 46	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		218,732 46	190,110 96
FIRE RANGING.—*Continued.*			
McDonald, J.		282 50	
McDonald, J.		235 00	
McDonald, Wm.		302 50	
McDonald, B.		142 50	
McDonald, J.		315 00	
McDonald, Allan	155 00		
Disbursements	1,584 38		
		1,739 38	
McDonald, A. J.	1,350 00		
Disbursements	3,806 16		
		5,156 16	
McDonnell, John		17 50	
McDougall, J. T. ....Disbursements		427 76	
McDougall, C.		354 75	
McFarland, J.		312 50	
McFarlane, J. A.		327 50	
McFarlane, W.		332 50	
McGauley, R.		202 50	
McGaw, Capt.		260 00	
McGee, H.		287 50	
McGee, John		255 00	
McGhie, Chas.		265 00	
McGraw, L.		71 50	
McGregor, J. A.		347 50	
McGowan, T.	795 00		
Disbursements	1,934 07		
		2,729 07	
McHughen, John		305 00	
McInnes, C.		389 75	
McIntosh, P.		5 00	
McIvor, A.		255 00	
McKechnie, J. A. ....Disbursements		165 18	
McKee, Ed.		122 50	
McKee, Thos.		382 50	
McKendry, W. B.		390 00	
McKenna, T.		280 00	
McKenna, P.		240 00	
McKenzie, Alex.		342 50	
McKenzie, J.		357 50	
McKinnon, T.		10 00	
McKinnon, H.		330 00	
McLaren, J.		382 50	
McLean, D.		330 00	
McLeod, E. H. ....Disbursements		55 27	
McLeod, B.		71 50	
McLeod, P.		71 50	
McLeod, J. A.		360 25	
McLeod, J.		63 25	
McMahon, A.		322 50	
McNally, B.		339 50	
McNee, G.		327 25	
McNee, E. D.		178 75	
McPhail, H.		320 00	
McRae, Alex.		227 50	
McQuestion, V.		312 50	
Narvanen, K.		5 00	
Nault, James	636 00		
Disbursements	3 20		
		639 20	
Naumann, E.		202 50	
Neaveau, James		267 50	
Carried forward		241,147 48	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		241,147 48	190,110 96
FIRE RANGING.—*Continued.*			
Neaveau, S.		160 00	
Nelson, N.		214 50	
Neep, Percy		280 00	
Neill, J.		345 00	
Netmegesic, M.		180 00	
Nevish, J.		57 50	
Nevison, W. H.		580 00	
Newman, P.		294 25	
Nicholes, Wm.		280 00	
Nichols Company, J. L. Supplies		194 62	
Neddery, R.		322 50	
Noel, J.		275 00	
Nolan, C.		127 50	
Norman, F.		292 50	
Norris, R. E.		42 50	
Norton, W. A.		330 00	
Nutterville, Wm.		17 50	
O'Brien, D.		290 00	
O'Brien, P.		305 00	
O'Brien, T.		46 75	
O'Bryan, A. E.		315 00	
O'Connor, Wm.		280 00	
O'Connor, Wm.		215 00	
O'Connor, J.		240 00	
O'Connell, J. F.		342 50	
Ogglestein, R.		393 25	
O'Grady, M.		357 50	
Oliver, J. A. Disbursements		120 00	
O'Neil, T.		347 50	
O'Neil, T.		357 50	
O'Neil, Fred.		145 75	
Orbick, O.		97 50	
Ore, A.		349 25	
Ormerod, H. G.		342 50	
Osborne, A.		317 50	
Oskaboose, S.		315 00	
Oskaboose, F.		315 00	
Ouillette, A.		302 50	
Ovenstone, J.		308 50	
Page, Fred.		357 50	
Palmer, Wm.		315 00	
Panasvich, E.		16 40	
Paquette, John		392 50	
Paradis, D.		60 00	
Parkhouse, H.		192 50	
Parkhurst, J.		347 50	
Passmore, T.		232 50	
Patrie, A.		92 50	
Patterson, Neal		316 25	
Paul, E.		198 00	
Paulter, C.		166 00	
Payette, F.		240 00	
Peacock, Wm.		125 00	
Pearce, Thos.		357 50	
Pearson, A.		117 50	
Pecott, J.		307 50	
Pellerin, E.		228 25	
Pelletier, C.		285 00	
Pelletier, E.		305 00	
Pellot, J. B.		305 00	
Pellow, H.		12 50	
Penard, R.		155 00	
Carried forward		256,369 25	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		256,369 25	190,110 96
FIRE RANGING.—*Continued.*			
Perrault, Fred.		50 00	
Perron, T.		277 50	
Perron, C.		190 00	
Perron, D.		184 25	
Peters, G. E.	735 00		
Disbursements	57 13		
		792 13	
Pettipher, C. R.		335 50	
Phelan, R.		50 00	
Picard, F.		313 50	
Picard, F.		313 50	
Pierie, Thos.		262 50	
Pigeon, C.		257 50	
Piggott, W. D.		382 50	
Piggott, J. A.		280 00	
Pingle, A.		330 00	
Pinnette, J.		324 50	
Poirier, E.		295 00	
Pollock, R.		285 00	
Poole, E. G.	1,125 00		
Disbursements	9,412 52		
		10,537 52	
Porteous, Wm.		370 00	
Pouquette, D.		6 75	
Pourpore, J.		187 00	
Powell, J.		317 50	
Powell, M.		317 50	
Premmo, P.		25 00	
Pritchard, F.		636 00	
Quackenbush, P.		360 00	
Quackenbush, C.		77 50	
Quail, Wm.		325 00	
Quartz, F. A.	196 00		
Disbursements	19 35		
		215 35	
Quinn, J. J.		345 00	
Rabbitts, Max	805 00		
Disbursements	9 70		
		814 70	
Ramsay, P.		322 50	
Raymond, A.		127 50	
Read, C.		481 00	
Regan, John		390 00	
Remilliard, S.		307 50	
Restoule, F.		297 50	
Revell, L. O.	915 00		
Disbursements	729 63		
		1,644 63	
Reynolds, J.		612 00	
Richardson, C.		207 50	
Richardson, S. G.		765 00	
Richardson, W. F.		35 00	
Richardson, R.		137 50	
Richardson, W. D.		310 00	
Richards, H.		255 00	
Ritcheson, W.		122 50	
Roach, Ed.		295 00	
Robertson, J.		387 50	
Carried forward		282,525 08	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		282,525 08	190,110 96
FIRE RANGING.—*Continued.*			
Robertson, W.		302 50	
Robinson, J. B.		370 50	
Rochford, A.		342 50	
Rockall, F. W.		260 00	
Ross, A.		350 00	
Rossboro, F.		231 00	
Rourke, E. O.		167 50	
Rowe, J.		367 50	
Roy, Alex.		325 00	
Roy, T.		375 50	
Ruddy, E. L., Co., Ltd. Supplies		1,067 60	
Ruddy, T.		390 00	
Rutherford, M.		190 00	
Rusnell, W. T.		87 50	
Russell, A.		3 50	
Ryan, W. H.		385 00	
Ryan, Wm.		325 00	
Sackrider, A.		2 50	
Sample, F.		167 50	
Savard, A.		137 50	
Sawyer, N.		347 50	
Sawyer, R.		347 50	
Scarlett, E.		242 50	
Scott, Robt.	835 00		
Disbursements	894 27		
		1,729 27	
Scott, Thos.		260 00	
Scott, T. E.		317 50	
Scott, D. S.		80 00	
Sculley, M.		147 50	
Searle, W.		25 00	
Seeley, P. P.		72 50	
Sharpe, J.		440 00	
Sheehan, D.		232 50	
Shields, H.		382 25	
Shea, J. O.		260 00	
Sherman, W.		5 50	
Sherwood, H. D.		147 50	
Short, J.		90 00	
Simmers, W. J.		287 50	
Simmons, J.		305 00	
Simpson, E.		338 25	
Simpson, A.		338 25	
Simpson, M.		322 50	
Sinclair, D.		340 00	
Sing, W. H.		139 00	
Singer, P.		25 00	
Singer, Wm.		77 50	
Skidmore, G. H.		67 50	
Slee, B.		21 00	
Small, M. A.		327 50	
Smellie, J.		302 50	
Smith, John		367 50	
Smith, J.		345 00	
Smith, G. B.		302 50	
Smith, T. D.		345 00	
Smith, G. D.		63 25	
Smith, S.		18 20	
Smith, G.		312 50	
Carried forward		298,145 65	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		298,145 65	190,110 96
FIRE RANGING.—*Continued.*			
Smith, D.		305 25	
Smith, David		230 00	
Smith, D.		302 50	
Smith, Dan		7 50	
Smith, H.		180 00	
Smith, V.		620 50	
Smith, C. C.		102 50	
Smyth, John		310 00	
Sodman, R.		77 50	
Souliere, W.		277 50	
Soway, J.		32 50	
Spaniel, P.		142 50	
Spears, Wm.		81 00	
Spencer, F.		92 50	
Spillett, A. F.		340 00	
Spillett, J. J.		340 00	
Spillett, P. L.		335 00	
Spooner, J. B.		190 00	
Spoon, P.		22 50	
Spreadborough, N.		367 50	
Stadelberean, B.		2 50	
Staniforth, A.		335 00	
Stata, S.		325 00	
Steep, Geo.		310 00	
Stevens, H.		235 00	
Stewart, D. J.		347 50	
Stewart, T.		127 50	
Stewart, A.		305 00	
Stewart, D.		9 90	
Stewart, J. A. ..... Disbursements		130 65	
Stitt, J. H.		277 50	
Stover, R. T.		300 00	
Strange, B.		382 50	
Stratton, R.		380 00	
Stringer, K.		295 00	
St. Dennis, Chas.		275 00	
St. Dennis, A.		190 00	
St. Jane, J.		270 00	
Sudds, D.		346 50	
Sullivan, P.		313 50	
Sullivan, N.		295 00	
Sutherland, J. W.		342 50	
Swanson, G.		346 50	
Sweeney, L.		85 00	
Tabbert, H.		287 50	
Tackney, Thos.	865 00		
Disbursements	678 63		
		1,543 63	
Tait, J.		390 00	
Tait, A.		390 00	
Tallon, M.		330 00	
Tang, J.		335 00	
Taylor, C.		215 00	
Thibb, E.		295 00	
Thomas, H.		343 00	
Thompson, J. W.		325 00	
Thomson, W. C.		296 00	
Thomson, J. L.		387 50	
Carried forward		313,867 08	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		313,867 08	190,110 96
FIRE RANGING.—*Continued.*			
Thompson, F.		305 00	
Tichborne, A.		556 00	
Tomlinson, C.		315 00	
Toohey, C.		112 50	
Toomer, S.		285 00	
Torrance, J. A.		320 00	
Tousseant, D.		192 50	
Tower, O.		345 00	
Tremblay, E.		207 50	
Tremblay, J.		197 50	
Tripp, E. C.		350 00	
Tryon, W.		152 50	
Turcotte, J.		245 00	
Turennie, O.		50 00	
Turpin, G. O.		198 00	
Tyson, John		320 00	
Urquhart, A.	840 00		
Disbursements	1,207 70		
		2,047 70	
Vanluven, M.		120 00	
Veley, Wm.		285 00	
Vincent, Thos.		282 50	
Vincent, H. T.		480 00	
Viseau, G.		3 75	
Viseau, L.		3 75	
Volker, P.		100 00	
Walker, G. W.		340 00	
Walker, E.		192 50	
Walsh, J.		206 25	
Wanamaker, W.		357 50	
Wanamaker, O.		542 00	
Ward, J.		368 00	
Ward, D.		402 50	
Warren, A.		275 00	
Watters, A. M.		357 50	
Watts, Geo. ....Disbursements		65 00	
Weiler, C.		305 00	
Weinholdt, C.		350 00	
Weir, Geo.		320 00	
Welch, J.		325 00	
Wesley, W. C.		162 50	
West, Wm.		342 50	
West, Walter.		295 00	
West. H.		342 50	
West, G.		165 00	
Whitmore, D.		347 50	
Wickens, H.		374 00	
Wiggins, J. R.		75 00	
Wildman, A. R.		87 50	
Wilkes, L.		30 25	
Williams, S.		343 75	
Willis, E.		316 25	
Wilson, John		101 75	
Wilson, J.		382 50	
Wilson, J. G.		253 00	
Wilson, J. H.		320 00	
Wilson, B.		230 00	
Wilson, W. J.		302 50	
Wilson, A. B.		282 50	
Carried forward		330,501 53	190,110 96

Appendix No. 6.—Continued.

Service.	$ c.		$ c.
Brought forward		330,501 53	190,110 96
FIRE RANGING.—*Concluded.*			
Wilson, F.		6 25	
Wilson, D.	700 00		
Disbursements	1,285 83		
		1,985 83	
Wilson, J. B.		50 00	
Winters, O.		97 50	
Woodcock, Geo.	441 75		
Disbursements	18 10		
		459 85	
Woodcock, G.		313 50	
Woods, T. J.	800 00		
Disbursements	1,128 54		
		1,928 54	
Woods, Geo.		342 50	
Woods, Wm.		297 50	
Wright, H. H.		272 50	
Wright, E.		345 00	
Wright, C.		207 50	
Wright, J. S.		332 50	
Youmans, A.		379 50	
Young, Jesse		66 00	
Young, Wm.		347 50	
			337,933 50
FOREST RESERVES.			
Temagami Reserve, $39,694.04.			
Armstrong, H.		337 50	
Aubee, Theo.		385 00	
Aubin, N.		357 50	
Aymes, A. J.		275 00	
Barrett, T.		512 00	
Bechamp, Wm.		307 50	
Benard, B.		97 50	
Berlinquette, E.		310 00	
Black, Geo.		322 50	
Brownlee, F. C.		337 50	
Brosseau, Wm.		357 50	
Burnes, J. L.		267 50	
Campbell, A.		322 50	
Carleton, Geo.		317 50	
Clarke, Wm. G.		302 50	
Coghill, J. M.	448 00		
Disbursements	10 10		
		458 10	
Corbeil, Jos.		315 00	
Cunning, J. E.		95 00	
Denne, D.		250 00	
Descateaux, J.		315 00	
Desroisiers, J.		310 00	
Desrosiers, E.		330 00	
Didier, H.	805 00		
Disbursements	694 28		
		1,499 28	
Downey, F.		245 00	
Evaline, W.		372 00	
Faeris, R.		452 50	
Faulkner, D.		227 50	
Fillion, G.		227 50	
Carried forward		9,906 38	528,044 46

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		9,906 38	528,044 46
FOREST RESERVES.—*Continued.*			
Temagami Reserve.—Continued.			
Flanigan, W. G.		317 50	
Forbes, C.		252 50	
Francoeur, D.		307 50	
Fraser, J.		267 50	
Gale, W. J.		310 00	
Gauthier, O.		250 00	
Greenrod, S.		317 50	
Grenier, J.		322 50	
Griffith, R. K.		187 50	
Hartley, M.		365 00	
Hartt, I. B.		580 00	
Hartt, J. C.		77 50	
Harrison, J. W.		912 50	
Henry, R.		240 00	
Hindson, C. E.	1,208 00		
Disbursements	1,771 60		
		2,979 60	
Hoadley, John		305 00	
Jacob, S.		322 50	
Jenkins, W.		182 50	
Jennings, J. E.		92 50	
Johnston, W.		335 00	
Johnston, A. S.		337 50	
Jolicouer, E.		357 00	
Kennedy, Wm.		50 00	
Kennedy, J.		252 50	
Kilby, T.		265 00	
King, C. S.		155 00	
Laferier, L.		280 00	
Lamarche, A.		912 50	
Lamarche, R.		230 00	
Laporte, F.		297 50	
Laporte, M.		297 50	
Lavigne, P.		357 50	
Layman, F.		337 50	
Little, Roy		185 00	
Marion, C.		357 50	
Mathews, F. W.		335 00	
Miller, J. R.		292 50	
Millichamp, Thos.		107 50	
Morel, A.	546 00		
Disbursements	14 23		
		560 23	
Morin, John		327 50	
Morphy, C.		237 50	
Morris, D. R.		262 50	
Murdell, J.		87 50	
Murphy, Jas.		292 50	
McCart, J.		132 50	
McDonald, A.		167 50	
McGarvey, P.		335 00	
McIntyre, J. E.		322 50	
McKay, W.		10 00	
McKechnie, A.		320 00	
McKenzie, T.		322 50	
McKissock, B.		167 50	
McMullin, W.		322 50	
Carried forward		28,105 71	528,044 46

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		28,105 71	528,044 46
FOREST RESERVES.—*Continued.*			
Temagami Reserve.—Concluded.			
McNabb, Wm.		275 00	
Nadon, P.		320 00	
Neil, H. J.		320 00	
Nolan, C. J.		320 00	
Normand, L.		371 00	
Ogden, F. H.		337 50	
Olson, Thos.		210 00	
Papineau, J.		62 50	
Petrant, Wm.		322 50	
Pirie, J. B.		322 50	
Powell, John		320 00	
Reesor, G. O.		365 00	
Reilly, J.		302 50	
Richardson, R.		302 50	
Rogers, J.		167 50	
Saunders, W. J.		322 50	
Sharpe, F. W.		320 00	
Simpson, T.		325 00	
Smith, T. M.		337 50	
Stevens, V.		122 50	
Sutherland, E.		225 00	
Taylor, F.		230 00	
Thorley, C. W.		312 50	
Thorpe, T.		372 50	
Tremblay, L.		285 00	
Tremblay, J.		285 00	
Trothier, J.		337 50	
Viverais, D.		830 00	
Viverais, M.		342 50	
White, J.		315 00	
Williams, H. B.		22 50	
Williams, A. E.		260 00	
Wilson, B.		47 50	
Wilson, Alex.		322 50	
Winder, A.		152 50	
Young, R. J.	860 00		
Disbursements	642 33		
		1,502 33	
Metagami Reserve, $8,252.02.			
Bach, E. L.		340 00	
Baker, Wm.		357 50	
Blackwell, J. J.		350 00	
Briggs, A. V.		352 50	
Bruiette, F.		90 00	
Burden, John	885 00		
Disbursements	506 02		
		1,391 02	
Cadautte, Alex.		265 00	
Cameron, W. J.		357 50	
Cayen, J. B.		357 50	
Charette, N.		55 00	
Chatson, F. C.		380 00	
Chubb, Geo. W.		340 00	
Jack, J.		70 00	
Luke, Jas.		232 50	
Martin, Jas.		267 50	
Carried forward		44,900 06	528,044 46

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		44,900 06	528,044 46
FOREST RESERVES.—*Continued.*			
Metagami Reserve.—Concluded.			
Moffitt, A. E.		355 00	
McFayden, Jas.		556 00	
McFarline, D.		70 00	
Naview, R.		147 50	
Naview, J.		272 50	
Parkinson, R. K.		267 50	
Sauver, Fred.		190 00	
Sears, L.		265 00	
Stoddart, W. H.		210 00	
Thomas, O.		190 00	
Tuer, Wm.		235 00	
White, J. H.		287 50	
Mississaga Reserve, $26,854.08.			
Acheson, L.		644 00	
Acheson, P. T.		160 00	
Beal, Chas. R.		192 50	
Beaudin, S.		357 50	
Beckett, A. G.		205 00	
Belanger, T.		380 00	
Bergeron, J.		55 00	
Best, H.		360 00	
Buisson, Wm.		372 50	
Bulmer, Andy		357 50	
Carnfelt, D.		385 00	
Carpenter, R. J.		592 00	
Causley, P.		367 50	
Chappish, J.		343 75	
Clute, Geo.		330 00	
Cochrane, J. E.		260 00	
Cornett, W. G.		330 00	
Cousineau, Max		330 00	
Couverette, John		340 00	
Daw, Chas. E.		350 00	
Deschamp, B.		357 50	
Draper, Wm.		50 00	
Duck, W. S.		372 50	
Duval, C. A.	935 00		
Disbursements	2,708 08		
		3,643 08	
Ecker, C. M.		352 50	
Eveline, S.		340 00	
Fecto, Geo.		443 50	
Ferguson, E. A.		332 50	
Findlay, J.		401 50	
Fitzgerald, R.		32 50	
Godson, H.		395 00	
Heenan, P.		387 50	
Hillman, J.		395 00	
Hinder, P. G		340 00	
Hobson, B.		345 00	
Jean, A.		652 00	
Kade, J. A.		206 25	
Lavender, P.		342 50	
Leblanc, Lorne		375 00	
Legace, F.		110 00	
Carried forward		64,552 14	528,044 46

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		64,532 14	528,044 46
FOREST RESERVES.—*Continued.*			
Mississaga Reserve.—Concluded.			
Lewis, S.		342 00	
Luke, S.		242 00	
Marcoux, E.		337 50	
Martin, H.		286 00	
Massey, J.		50 00	
Miller, W. J.		468 00	
Mitchell, John		242 50	
Morrison, Andrew		345 00	
Mulvaney, C.		302 50	
Murray, John		372 50	
McGrath, B.		340 00	
McKay, Alex.		202 50	
McLaughlin, J.		392 50	
McLean, C.		302 50	
McWatch, P.		330 00	
McWatch, S.		330 00	
Nichols, H.		612 00	
Nightingale, G. E.		280 00	
O'Connell, C.		275 00	
Orange, Wm.		365 00	
Paquette, O.		337 50	
Piper, Geo. E.		189 75	
Poulin, N.		332 50	
Reid, J.		402 50	
Sailor, H.		343 75	
Seeley, C. F.		347 50	
Snider, F.		217 75	
Spanial, J.		308 00	
Stubbs, W. J.		310 00	
Tongas, J.		52 50	
Trudeau, N.		310 00	
Turner, S.		343 75	
Wells, Geo.		355 00	
Nepigon Reserve, $27,752.36.			
Allen, Wm.		437 25	
Ashcroft, Geo.		175 00	
Baker, A.		366 00	
Barton, J.		437 25	
Blanchard, G.		211 75	
Bliss, L. E. ..... Disbursements.		616 24	
Boissoneault, J.		437 25	
Bouchard, J.		598 50	
Cameron, P.		79 75	
Clark, W. R.		132 50	
Disando, M.		192 50	
Deschamp, D.		102 50	
Dumont, O.		420 75	
Esquaga, L.		212 50	
Farrel, C.		120 00	
Finlayson, J.		397 50	
Finlayson, D.		227 50	
Fitzback, J.		490 50	
Fitzback, D.		65 00	
Fitzpatrick, P.		437 25	
Florence, E.		192 50	
Godehere, J.		155 00	
Carried forward		81,305 13	528,044 46

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		81,305 13	528,044 46
Forest Reserves.—*Continued.*			
Nepigon Reserve.—Continued.			
Graham, D.		195 00	
Hardy, F.		437 25	
Hardy, R.		317 25	
Harper, G.		195 00	
Hendrickson, C.		3 75	
Holmes, J. A.		167 75	
Howson, B.		152 50	
Johnson, Wm.		7 50	
Kebuck, J.		2 50	
King, J.		347 50	
King, S.		397 50	
Kitcheinni, C.		180 00	
Lagard, L.		50 00	
Larone, Geo.		240 25	
Lash, A.		437 25	
Lavesque, J.		397 50	
Leo, P.		397 50	
Mann, L.		376 75	
Michael, S.		198 00	
Micholson, Geo.		120 00	
Micholson, C.		36 00	
Micholson, J.		407 50	
Mimault, E.		192 50	
Moore, H.		202 50	
Morriseau, J.		55 00	
Morriseau, P.		333 75	
Morrow, S.		437 25	
McDonald, M. C.		397 50	
McKechnie, J. A.	925 00		
Disbursements	217 58		
		1,142 58	
McLean, C. O.		208 00	
McLeod, E. H.	1,050 00		
Disbursements	5,137 29		
		6,187 29	
Nanee, T.		15 00	
Nanakowagosh, P.		195 25	
Nelson, A.		167 50	
Netamegesic, F.		195 00	
Netamegesic, Fred.		202 50	
Netamegesic, E.		170 00	
Newington, H.		305 00	
Nadon, P.		172 50	
Oscopekeda, J.		67 50	
Peters, J.		120 00	
Plouffe, W.		182 50	
Ponton, R.		3 75	
Porter, Thos.		291 75	
Poile, Joseph		191 75	
Poile, John		221 25	
Rae, A.		332 75	
Rudolph, L.		437 25	
Shapwakessic, O. M.		202 75	
Shapwakessic, A.		192 50	
Smith, H.		480 00	
Sutherland, J.		50 00	
Tepiscookeesic, P.		211 75	
Thompson, J.		503 50	
Carried forward		100,437 50	528,044 46

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		100,437 50	528,044 46
Forest Reserves.—*Concluded.*			
Nepigon Reserve.—Concluded.			
Viccars, T. R.		385 50	
Vincent, J.		437 25	
Wadow, J.		280 00	
Ward, J.		44 00	
Watt, Thos.		2 50	
Watt, Moses		3 75	
Wawea, A.		120 00	
Willan, Wm.		652 25	
Wilson, F.		189 75	
Eastern Reserve, $2,704.17.			
Bishop, John		350 00	
Brown, H.		350 00	
Gilmour, E.		350 00	
Hughes, Geo.		350 00	
Laundry, A.		332 50	
Tapping, Thos.	600 00		
Disbursements	21 67		
		621 67	
Young, Wm.		350 00	
Sibley Reserve, $100.00.			
Oliver, J. A.		100 00	
			105,356 67
Cullers' Act.			
Oliver, J. A. ....Disbursements			10 40
Reforestration.			
Bell Telephone Company	35 78		
Express and cartage	38 13		
		73 91	
Supplies		1,018 18	
Labor		4,721 39	
Sundries		262 18	
			6,075 66
Mines and Mining.			
Miller, W. G. Provincial Geologist, services	5,000 00		
Disbursements	413 54		
		5,413 54	
Knight, C. W., 1st Assistant Geologist, services	2,500 00		
Disbursements	924 19		
		3,424 19	
Burrows, A. G., 2nd Assistant Geologist, services	2,350 00		
Disbursements	593 89		
		2,943 89	
Hopkins, P. E., 3rd Assistant Geologist, services	1,800 00		
Disbursements	609 30		
		2,409 30	
Rogers, W. R., Topographer, services	1,950 00		
Disbursements	43 35		
		1,993 35	
Bell, W. J., Cartographer, services		1,600 00	
Carried forward		17,784 27	639,487 19

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		17,784 27	639,487 19
MINES AND MINING.—*Continued.*			
Mickle, G. R., Mine Assessor, services	4,200 00		
Disbursements	344 45		
		4,544 45	
Godson, T. E., Mining Commissioner, services	4,500 00		
Morris, W. H., Mining Commissioner's Clerk, services	1,600 00		
White, Miss N., Stenographer	410 68		
Disbursements	1,061 90		
		7,572 58	
Sutherland, T. F., Chief Inspector of Mines, services	2,700 00		
Disbursements	758 50		
		3,458 50	
Collins, E. A., 1st Assistant Inspector of Mines, services	2,400 00		
Disbursements	1,088 19		
		3,488 19	
McMillan, J. G., 2nd Assistant Inspector of Mines, services		1,670 00	
Bartlett, J., 3rd Assistant Inspector of Mines, services	1,728 50		
Disbursements	88 99		
		1,817 49	
Stovel, J. H., 4th Assistant Inspector of Mines, services	2,400 00		
Disbursements	1,509 60		
		3,909 60	
Jackson, P. A., Surveyor, services		619 11	
McArthur, T. A., Inspector of Recorder's Offices, services	800 00		
Disbursements	413 30		
		1,213 30	
Beno, J. W., services	449 02		
Disbursements	333 30		
		782 32	
Cleary, J. F., services		48 00	
Devanney, Thos., services		22 00	
Foisy, F., services		126 00	
Hawley, J. E., services	247 50		
Disbursements	39 00		
		286 50	
Kerr-Lawson, D. E., services		156 92	
Ledoux, Prof. A., services	692 29		
Disbursements	725 37		
		1,417 66	
Moffatt, Miss A., services		100 00	
Morgan, C. B., services	50 00		
Disbursements	13 32		
		63 32	
Moreau, Albert, services		28 50	
Near, A. E., services	700 00		
Disbursements	207 85		
		907 85	
Parsons, Prof. A. L., services	423 08		
Disbursements	400 59		
		823 67	
Scott, John, services	750 00		
Disbursements	211 35		
		961 35	
King's Printer		446 96	
Express		11 00	
Carried forward		52,259 54	639,487 19

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		52,259 54	639,487 19
MINES AND MINING.—*Concluded.*			
Telegraphing		108 88	
Typewriters, repairs, etc.		107 30	
Sundries		102 93	
			52,578 65
RESEARCH WORK.			
Clarke, A. L., services			833 33
MINING RECORDERS.			
Browning, A. J., Recorder	1,150 00		
Loudon, W. E., Clerk	270 39		
Boyer, P. H., Clerk	112 50		
Disbursements	920 74		
		2,453 63	
Campbell, C. A., Recorder	975 00		
Shanahan, Miss M., Stenographer	538 46		
Loudon, W. E., Clerk	171 15		
Disbursements	389 30		
		2,073 91	
Gauthier, G. H., Recorder	1,500 00		
O'Brien, J. D., Clerk	1,066 74		
Loudon, W. E., Clerk	131 53		
Disbursements	1,144 10		
		3,842 37	
Hough, J. A., Recorder	1,300 00		
Ginn, H. G., Clerk	939 86		
Powers, Miss E. M., Stenographer	335 00		
Loudon, W. E., Clerk	426 16		
McGonigal, Miss G., Stenographer	242 50		
Disbursements	1,227 99		
		4,471 51	
Miller, N., Recorder	1,050 00		
Disbursements	159 15		
		1,209 15	
Morgan, J. W., Recorder	1,050 00		
Disbursements	513 20		
		1,563 20	
Morgan, M. R., Recorder	950 00		
Disbursements	322 39		
		1,272 39	
McAulay, N. J., Recorder	1,850 00		
Sarsfield, J. M., Clerk	1,225 00		
Loudon, W. E., Clerk	134 62		
Munro, Miss E., Stenographer	782 50		
Smith, Miss M., Stenographer	210 00		
Disbursements	790 52		
		4,992 64	
McQuire, H. F., Recorder	500 00		
Disbursements	158 93		
		658 93	
Sheppard, H. E., Recorder		814 50	
Skill, A., Recorder		611 93	
Spry, W. L., Recorder	825 00		
Disbursements	118 20		
		943 20	
Express	70 04		
King's Printer	937 20		
Telegraphing	10 55		
		1,017 79	
			25,925 15
Carried forward			718,824 32

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward			718,824 32
PROVINCIAL ASSAY OFFICE.			
Leat, Arthur		357 84	
McNeill, W. K.	1,900 00		
Disbursements	60 60		
		1,960 60	
Rothwell, T. E.	1,325 00		
Disbursements	161 20		
		1,486 20	
Todd, E. W.		179 99	
Supplies	859 28		
Disbursements	232 92		
		1,092 20	
EXPENSES NOT OTHERWISE PROVIDED FOR.			5,076 83
Canadian Northern Express Co., express		1 52	
Fensom, G. R., supplies		14 05	
Parsons, Prof. A. L. disbursements		123 56	
			139 13
MINERAL DISPLAYS AT EXHIBITIONS.			
Aikins, W. E., Services *re* Toronto Exhibition		8 75	
Green, W. F., Services *re* Toronto Exhibition		56 00	
Stephens, J., Services *re* Toronto Exhibition		8 00	
West, W. J., Services *re* Toronto Exhibition		40 00	
General Disbursements *re* Toronto Exhibition		1,157 60	
			1,270 35
LEGAL ASSISTANCE ENFORCING MINING ACT.			
Donovan, T., Expenses *re* case of J. Osmak			30 95
SOCIETY MEMBERSHIP FEES			46 00
SURVEYS			43,214 76
BOARD OF SURVEYORS			200 00
INVESTIGATION OF TREE DISEASES			13,734 87
INSURANCE			360 23
ALLOWANCE TO SCHOOL SECTIONS IN TOWNSHIP OF SOUTH WALSINGHAM			150 00
CANADIAN FORESTRY GRANT			300 00
REFUNDS—Miscellaneous			8,993 80
COLONIZATION AND IMMIGRATION.			
PRINTING, ADVERTISING, ETC.		16,702 71	
ADVANCE COST OF FARM LABOURERS' TRANSPORTATION		536 65	
LAND GUIDES		1,259 00	
EMIGRATION WORK IN GREAT BRITAIN		20,243 64	
ALLOWANCE TO RICHARD REID		3,188 00	
RENTAL IMMIGRATION OFFICE		1,882 07	
TRAVELLING EXPENSES LONDON OFFICIALS		182 81	
IMPERIAL TAX		481 22	
WOMEN'S WELCOME HOSTEL		1,400 00	
WOMEN'S HOSTEL AND TRAVELLERS' AID		500 00	
			46,376 10
CONTINGENCIES.			
Departmental.			
Printing and Binding	2,642 20		
Stationery	6,948 47		
		9,590 67	
Carried forward		9,590 67	838,717 34

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	9,590 67	838,717 34
CONTINGENCIES.—*Continued.*			
Departmental.—Concluded.			
Postage	2,599 45		
Express	327 54		
		2,926 99	
Telegraphing	605 71		
Car Fare	60 00		
		665 71	
Subscriptions	580 78		
Advertising	15,834 06		
		16,414 84	
Typewriters and repairs	....	1,302 53	
Ferguson, Hon. G. H., travelling expenses	500 00		
Grigg, A., travelling expenses	55 72		
Hele, C. C., travelling expenses	137 12		
Hutcheon, J., disbursements	516 88		
Rorke, L. V., disbursements	100 00		
Keefer, F. H., legal services	1,757 30		
White & Williams, legal services	58 52		
Rice, Lewis & Son, surveyor's posts	440 00		
		3,565 54	
Extra Clerks	7,774 72		
Maps	5,720 54		
Sundries	175 76		
		13,671 02	
			48,137 30
Bureau of Mines.			
Printing and Binding	1,275 49		
Stationery	3,142 24		
		4,417 73	
Postage	1,125 30		
Telegraphing	57 15		
Express and Cartage	77 55		
Advertising	1,242 50		
Subscriptions	148 58		
Maps	323 01		
		2,974 09	
Typewriters, repairs, etc.	452 50		
Dunn, A. J., searching titles	100 10		
Gibson, T. W., travelling expenses	27 00		
		579 60	
Extra Clerks	2,187 93		
Sundries	203 15		
		2,391 08	
			10,362 50
Forestry.			
Zavitz, E. J., travelling expenses	189 76		
White, J. H., travelling expenses	14 50		
		204 26	
Postage	300 51		
Typewriters, etc.	439 00		
Extra Clerks	746 68		
Supplies	302 36		
Sundries	106 56		
		1,895 11	
			2,099 37
Colonization.			
Printing and Binding	37 93		
Stationery	361 71		
		399 64	
Carried forward	....	399 64	899,316 51

Appendix No. 6.—Concluded.

Service.	$ c.	$ c.	$ c.
Brought forward	....	399 64	899,316 51
COLONIZATION.—*Concluded.*			
Postage	860 00		
Express and Cartage	125 85		
		985 85	
Telegraphing	135 81		
Subscriptions	41 20		
Typewriters, repairs, etc.	53 25		
		230 26	
Argue, J., travelling expenses	36 70		
Bindon, F. W., travelling expenses	427 40		
Farrell, John, travelling expenses	293 54		
Jones, R. A., travelling expenses	514 05		
Macdonell, H. A., travelling expenses	137 15		
Thompson, J., travelling expenses	329 42		
Tutt, H., travelling expenses	431 86		
Sundries	51 89		
		2,222 01	
			3,837 76
			903,154 27

D. GEO. ROSS,
Accountant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 7.

Statement of expenses on account of various services under the direction of the Department of Lands, Forests and Mines, for the year ending October 31st, 1917.

Service.	$ c.	$ c.
Algonquin Park	28,596 23	
Algonquin Park, Cleaning Right-of-Way	5,027 66	
		33,623 89
Quetico Provincial Park		9,056 50
Veterans' Commutation		150 00
Royal Nickel Commission		45,721 64
Legal Investigations		2 90
		88,554 93

D. GEO. ROSS,
Accountant.

ALBERT GRIGG.
Deputy Minister of Lands and Forests.

Appendix No. 8.

PATENTS OFFICE (LANDS BRANCH).

Statement of Patents, etc., issued from 1st November, 1916, to 31st October, 1917.

Public Lands (late Crown)	462
" " (late School)	22
" " (late Clergy Reserves)	7
" " (University)	8
Free Grant Lands (Act of 1913)	298
" " " (Act of 1901) (Veterans)	195
Mining Lands (Patents)	542
" " " (University)	3
Mining Leases	138
Crown Leases	24
Licenses of Occupation	53
Timagami Island Leases	4
Sand and Gravel Licenses	22
Total	1,778

CHARLES S. JONES,
Patents Clerk.
W. C. CAIN,
Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister of Lands, Forests and Mines.

Appendix

Woods and

Statement of Timber and Amounts accrued from Timber Dues, Ground

Quantity and

Agencies.	Area covered by timber licenses.	Saw logs.				Boom and	
		Pine.		Other.		Pine.	
	Square miles.		Feet B.M.	Pieces.	Feet B.M.	Pieces.	Feet B.M.
Western Timber District	10,168¼	5,105,001	187,349,181	772,450	26,731,557	75,342	8,490,009
Belleville Timber District	872	17,431	563,449	60,921	2,385,855	39	5,842
Ottawa Timber District	5,273½	315,205	11,471,952	159,528	5,037,261	2,490	265,644
	16,313¾	5,437,637	199,384,582	992,899	34,154,673	77,871	8,761,495

General Statement

Agencies.	Railway Ties.	Posts.	Poles.	Stave Bolts.	Pulpwood.	Transfer bonus.	Interest.
		Cords.	Pieces.	Cords.	Cords.		
						$ c.	$ c.
Western Timber District	1,542,610	715	5,321	1,390	207,654	5,485 00	18,488 25
Belleville Timber District	1,211	9	....	....	151	400 10	1,305 25
Ottawa Timber District	1,005	660	768	....	15,866	780 00	1,295 61
	1,544,826	1,381	6,089	1,390	223,671	6,665 10	21.089 11

JOHN HOUSER,
Chief Clerk in Charge.

No. 9.

FORESTS.

Rent and Bonus during the year ending 31st October, 1917.

DESCRIPTION OF TIMBER.

Dimension.		Cedar.	Piling.			Cordwood.		Tan Bark.
Other.						Hard.	Soft.	
Pieces.	Feet B.M.	Lineal feet.	Lineal feet.	Pieces.		Cords.	Cords.	Cords.
23,248	2,392,247	2,424	168,363	5,845	328,992	29,104	22,979	3,106
536	85,711	....	....	....	....	....	....	54
3,810	466,714	....	....	....	....	2,855	526	772
27,594	2,944,672	2,424	168,363	5,845	328,992	31,959	23,505	3,932

of Timber.—Concluded.

Amounts accrued.

Trespa		Bonus.	Deposits timber sales.	Ground rent.	Fire protection.	Total.
$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
10,483 80	621,333 63	466,094 59	125,000 01	64,815 00	86,604 26	1,398,304 54
717 19	3,447 01	376 96	....	5,593 00	....	11,839 51
329 22	26,329 91	....	....	28,461 86	28,722 80	85,919 40
11,530 21	651,110 55	466,471 55	125,000 01	98,869 86	115,327 06	1,496,063 45

ALBERT GRIGG,
Deputy Minister.

Appendix No. 10.

WOODS AND FORESTS BRANCH.

Statement of revenue collected during the year ending October 31st, 1917.

Amount of	Western collections at Department	$1,543,893 94
do	Belleville collections at Department	19,046 13
do	Ottawa collections at Department	132,763 01
		$1,695,703 08

WOODS AND FORESTS BRANCH REVENUE,

October 31st, 1917.

Western District—		
Timber dues	$728,513 97	
Bonus	515,032 45	
Ground rent	64,815 00	
Interest on dues	18,059 79	
Interest on ground rent	428 46	
Transfer fees	5,485 00	
Timber sale deposit	125,000 01	
Fire protection	86,604 26	
		$1,543,938 94
Ottawa District—		
Timber dues	$73,457 74	
Ground rent	28,461 86	
Interest on dues	812 21	
Interest on ground rent	483 40	
Transfer fees	780 00	
Fire protection	28,722 80	
		132,718 01
Belleville District—		
Timber dues	$10,944 89	
Bonus	802 89	
Ground rent	5,593 00	
Interest on dues	678 64	
Interest on ground rent	626 61	
Transfer fees	400 10	
		19,046 13
		$1,695,703 08

WOODS AND FORESTS.

Bonus	$640,835 35
Timber dues	832,467 24
Ground rent	100,408 33
Transfer fees	6,665 10
Fire protection	115,327 06
	$1.695,703 08

JOHN HOUSER,
Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister.

Appendix No. 11.

Statement of work done in the Military Office, Lands Branch of the Department of Lands, Forests and Mines, during the year ending October 31st, 1917.

References for Veteran Patents issued	158
Locations under military certificates	87
Certificates applied in payment of lands	14
Certificates surrendered for commutation money	3
Letters received	1,890
Letters written	2,100
Special letters to agents	320
Special letters to mining recorders	110
Maps and reports supplied to veterans	470
Printed forms sent out	450
Copies of Veteran Act supplied	30

H. E. JOHNSTON,
Military Clerk.
W. C. CAIN,
Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister.

Appendix No. 12.

LIST OF CULLERS.

Anderson, M. M.	Almonte.
Allan, James D.	Bracebridge.
Appleton, Erwin B.	Bracebridge.
Albert, Andrew	Ottawa.
Adams, J. Q.	Longford Mills.
Anderson, Patrick J	Campbellford.
Anderson, J. C.	Gravenhurst.
Allan, Alfred	Ottawa.
Allen, R. A.	Bannockburn.
Aikens, Geo. M.	French River.
Appleby, Ridley	Katrine.
Adams, James M.	Sault Ste. Marie.
Aylward, James	Peterborough.
Archibald, John L.	Keewatin.
Austin, Wm. G.	Renfrew.
Anderson, Charles	Little Current.
Anderson, John	Cartier.
Adair, Thomas Albert	Gananoque.
Anderson, J. G.	Alpena, Mich.
Alexander, Samuel	Arden.
Adams, Wm.	Westmeath.
Arkle, George	Kenora.
Armstrong, Jas. Theodore	McKellar.
Armstrong, Thomas J.	Arnprior.
Acheson, Ira M.	Westmeath.
Albert, Alfred E.	Ottawa.
Alma, John E.	Hawkesbury.
Adams, George A.	Longford.
Ansley, John Albert	Thessalon.
Ansley, John Jenkins	Thessalon.
Ainslie, Alexander	Spanish.
Apleton, E. A.	Kenora.
Arnill, William	Iron Bridge.
Adams, Fred.	L'Orignal.
Alexander, R. Harvey	Spragge.
Alexander, J. Albert	Spragge.
Ainslie, Donald McF.	Whitestone.
Ansley, William	Thessalon.
Argues, W. A.	Kearney.
Almers, John	Kenora.
Allard, Telesphore Jos.	W. Fort William.
Andrews, Geo. E.	Massey.
Brophy, Michael Patrick	Massey Station.
Boland, Abraham	Cartier.
Brown, Singleton	Bracebridge.
Barry, Thomas James	Hastings.
Blanchet, Paul Fred'k.	Ottawa.
Bird, W. S.	Parry Sound.
Bayley, James T.	Gravenhurst.
Bell, Henry	Ottawa.
Beach, Herbert Mahlon	Ottawa.
Barry, Thomas	Millbridge.
Beatty, W. R.	Parry Sound.
Brooks, Frederick Wm.	Mackay's Station.
Brown, Robt. D.	Port Sidney.
Breed, Arthur G.	Penetanguishene.
Barnes, Thomas Geo. Lee	Muskoka Mills.
Buchanan, Robert	Coldwater.
Beck, Jacob Frederick	Penetanguishene.
Bird, Joseph Manly	Muskoka Mills.
Boyd, John F.	Thessalon.
Brandon, Martin W.	Peterborough.
Bell, John C.	Peterborough.
Bartlett, George W.	Warren.
Brown, Silas	Klock's Mills.
Boland, W. G.	Eganville.
Baulke, George R.	Aylmer, Que.
Bouchey, Arthur	Massey.
Buchanan, Mark	Trout Mills.
Barrett, W. J.	Thessalon.
Bromley, Thomas	Pembroke.
Bremner, John L.	Adamston.
Breen, Bernard	Garden River.
Buie, Dougal	Providence Bay.
Baker, Thomas	Blind River.
Blais, Felix	Hull, Que.
Balsdon, George	Keewatin.
Bromley, W. H.	Pembroke.
Bowers, Isaac	Little Current.
Brown, Thomas	Barrie.
Bass, Walter R.	W. Huntingdon.
Bates, Robert	Kenora.
Binnie, Thomas	Port Arthur.
Blair, William	Keewatin.
Bick, Thomas	Bobcaygeon.
Burke, John Thomas	Midland.
Buchan, Sterling	L'Orignal.
Brown, Joseph A.	Spanish.
Baird, P. C.	Rainy River.
Brill, J. W.	Mine Centre.
Beattie, Arthur W.	Arnprior.
Brock, H. S.	Ottawa.
Benson, John Bird	Midland.
Brennan, Rich'd Lawrence	Peterborough.
Brown, Hugh Riside	Huntsville.
Bryan, Frank	Keewatin.
Bennett, Edward Clinton	Ahmic Harbour.
Blaine, Harvie Thomas	Orillia.
Barrett, Thomas	Barrie.
Bickell, James Manuel	Sault Ste. Marie.
Buisson, William	Sudbury.
Borrett, James A.	Sault Ste. Marie.
Bliss, C. Lidden	Sudbury.
Bray, James	Kinmount.
Bremner, George	Arnprior.
Bromley, Samuel	Pembroke.
Brown, A. C.	Fitzroy Harbour.
Berlinquet, Julius	Opimicon, Que.
Blastorah, Fred. L.	Harwood.
Burns, Clifton H.	Little Current.
Beaumont, Ernest	Parry Sound.
Beattie, Alex.	Whitney.
Brennan, Reginald	Gravenhurst.
Boyd, George	Gravenhurst.
Bissell, Geo. Thomas	Trenton.
Baxter, Richard	Deseronto.
Breeaugh, Edward	Deseronto.
Boyd, Geo. A.	Thessalon.
Buchan, Frederick	Arnprior.
Bradbury, Kerwood	Blind River.
Belanger, John B.	Mattawa.
Bird, J. F.	Bracebridge.
Beddome, W. E.	Dryden.
Barrett, Patrick	Arnprior.
Brundage, Alfred W.	Pembroke.
Brougham, Thomas	Eganville.
Blair, Robert I.	Arnprior.
Benson, John W.	Sturgeon Bay.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Beck, Chas. M., Jr.	Penetanguishene.
Beatty, W. J.	Coldwater.
Burns, C. W., Jr.	South River.
Bell, John Henry	Burk's Falls.
Berry, Harold	Labelle, Q.
Black, George	Barwick.
Bettes, John Hiram	Muskoka Mills.
Brady, John	Renfrew.
Brown, James	Buckingham, Q.
Brooks, W. J.	Blind River.
Bertrand, Allan	Nairn Centre.
Brinkman, Alex. B.	Sault Ste. Marie.
Black, Jacob	Barwick.
Beattie, W. J.	Arnprior.
Bromley, William	Westmeath.
Bissell, Hartie	Trenton.
Brown, Robert	Starrat.
Beaton, Hugh	Waubaushene.
Bailey, Arthur	Farry Sound.
Burd, James Henry	Parry Sound.
Bailey, Samuel James	Orillia.
Burton, Tinswood	Renfrew.
Boyes, James	Huntsville.
Brown, John	Rockdale.
Brennan, Edward Scott	Sundridge.
Bell, John Arguey	Klock's Mills.
Bromley, Edw. H.	Pembroke.
Bliss, Lawrence E.	Byng Inlet.
Buee, Neil	Spanish Station.
Brazziel, Leonard	Spanish Station.
Bowie, James	Bryson, Que.
Barrie, Nicholas J.	Ottawa.
Burke, J. D.	Kenora.
Bowen, Thomas	Deseronto.
Brown, James F.	Baysville.
Blastorah, Bernard	Harwood.
Brannan, William H.	Pembroke.
Bromley, Thomas	Webbwood.
Barr, J. C.	Fort Frances.
Bradley, J. M.	Mine Centre.
Burns, Dominick	Webbwood.
Blaikie, Campbell D.	Fort Frances.
Bury, Henry J.	Stratton.
Brown, R. A.	Cartier.
Brouse, Silas	Webbwood.
Byrne, James	Kenora.
Buchan, A.	Ft. William.
Bailey, Alex.	Thor Lake.
Bennett, Oscar T.	Little Current.
Campbell, Robert John	Flinton.
Carpenter, John A.	Arnprior.
Campbell, Alex. J.	Trenton.
Carson, James	Bracebridge.
Campbell, J. M.	Bracebridge.
Campbell, Robert	Bracebridge.
Clairmont, Joseph	Campbellford.
Clarkson, Robert J.	Parry Sound.
Carruthers, Aaron	Hintonburg.
Calder, Wm. J.	Bark Lake.
Chew, Joseph	Gravenhurst.
Cole, James Colin	Ottawa.
Cameron, Wm.	Collin's Inlet.
Cain, Robert	Midland.
Crawford, Stephen W.	Thessalon.
Cochrane, George	Peterborough.
Coburn, John	Lindsay.
Crewe, Nathaniel	Bobcaygeon.
Cameron, Alexander	Norman.
Chrysler, Frank R. L.	Webbwood.
Callaghan, Thomas, Jr.	Campbellford.
Carson, Hugh	Kenora.
Calder, George	Woodville.
Callaghan, Dennis	Campbellford.
Corrigan, Robt. T.	Emo.
Cameron, John H.	Kenora.
Carson, Melvin	Little Current.
Cameron, John K.	Spanish River.
Cassidy, William	Little Current.
Coons, Geo. Washington	Peterborough.
Chisholm, Geo. Leopold	Sault Ste. Marie.
Clark, Wm. J.	Birkendale.
Carr, Herbert E.	North Bay.
Cochrane, Alfred L.	Muldoon, Que.
Campbell, George	Fort Frances.
Chalmers, George James	Peterborough.
Caverly, David Charles	Parry Sound.
Campbell, Archibald J.	Little Current.
Close, John L.	Arnprior.
Carmichael, Donald	Arnprior.
Carty, John	Arnprior.
Cleary, Patrick M.	Arnprior.
Caldwell, James M.	Callender.
Cushing, John J.	Davidson, Que.
Crebo, William	Thessalon.
Cullen, Michael J.	Massey Station.
Cuthbertson, William	Arnprior.
Carss, Percy	Thessalon.
Coghlan, Michael	Chapeau, Que.
Cameron, Alexr. Gordon	Beauchene, Q.
Cassaday, W. W.	Emo.
Carter, Robert E.	Fesserton.
Coleman, Jos.	Baysville.
Cardiff, Geo. McDougall	Sudbury.
Cameron, W. D.	Kenora.
Crandal, F.	Port Arthur.
Campbell, James R.	Eganville.
Campbell, John A.	Galleta.
Caillier, Hyacinth	Arnprior.
Chamberlain, Thomas	Bobcaygeon.
Cooper, David Allan	Millbrook.
Cox, Henry	Ballerica, Que.
Currie, James	Ottawa.
Clarkson, A. E.	Midland.
Clairmont, E.	Gravenhurst.
Cameron, W. F.	Sturgeon Bay.
Connolly, David	Gravenhurst.
Campbell, P. C.	Sault Ste. Marie.
Cadenhead, Alexander	Midland.
Carpenter, R. J.	Arnprior.
Christie, William Pringle	Severn Bridge.
Campbell, C. V.	Sault Ste. Marie.
Clegg, Samuel	Peterborough.
Clairmont, William L.	Gravenhurst.
Cook, Sydney P. W.	Spanish Station.
Corrigan, John	Baysville.
Chalmers, Alexander M.	Peterborough.
Charlton, George A.	Collingwood.
Cahill, Thomas	Nosbonsing.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Chew, Manley	Midland.
Cooper, James Eddly	Saurin.
Cook, Reinhardt	South River.
Crowe, Cecil	Bobcaygeon.
Callaghan, Denis	Trenton.
Collins, James	Barryville.
Claffey, Edward D.	Fort William.
Coyne, Phin	Chelmsford.
Constantine, Eudore	Blind River.
Cameron, Ewan	Gordon Lake.
Campbell, Daniel N.	Buck'gham, Que.
Canniff, R. W.	Kenora.
Cassidy, S. C.	Dunchurch.
Charleston, John Baptiste	Ottawa.
Comer, Billa F.	Tweed.
Carter, George	Sundridge.
Corrigan, Robt. J.	Emo.
Caswell, Grant	Coldwater.
Caswell, Geo.	Coldwater.
Chemir, David A.	Pembroke.
Clairmont, Philadelp L.	Gravenhurst.
Crowe, Edgerton	Bobcaygeon.
Castonquay, A. C.	Chelmsford.
Clark, Donald Allan	Port Arthur.
Charette, Herbert	Devlin.
Christie, Uriah W.	Fort Frances.
Clark, Joseph C.	Fort Frances.
Crowe, Leslie	Bobcaygeon.
Campbell, Duncan W.	Stewartville.
Callahan, Thomas N.	Arnprior.
Clements, Albert James	Bent River.
Carney, Albert	Sault Ste. Marie.
Collins, Arthur	Massey Station.
Carter, George	Lavelle, Que.
Chitty, Alfred E.	Kenora.
Cardiff, Richard J.	Arnprior.
Conway, Thomas	Barry's Bay.
Costello, Thomas M.	Antrim.
Cross, R. J.	Silver Islet.
Clark, R. H.	Port Arthur.
Clark, Wm. R.	Port Arthur.
Coombs, A. B.	Bracebridge.
Cameron, A. F.	Emo.
Campbell, J. S.	Fort Frances.
Clearihue, Geo. A.	784 Hubert St., Montreal, Que.
Cuddihey, J. T.	Pembroke.
Cameron, Ronald	Ignace.
Cole, J. E.	Kenora.
Currie, J. E.	Kenora.
Carroll, Peter	McDougall's Mills.
Clempson, A. J.	Dryden.
Didier, Hector	Mattawa.
Doran, Frank	Barryville.
Dunning, E. Percival	Parry Sound.
Duff, R. J.	Arnprior.
Durrill, John W.	Ottawa.
Dickson, John	Sundridge.
Dickson, James L.	Michipic'ten Hr.
Dobie, Harry	Sault Ste. Marie.
Deacon, Charles	Sault Ste. Marie.
Danter, R. W.	Parry Sound.
Doyle, T. J.	Eau Claire.
Dobie, Alexander R.	Blind River.
Darling, J. M.	Byng Inlet.

Dillon, John	Calabogie.
Durrell, Jos. Nelson	P'rt'ge du Ft., Q.
Durrell, John	Callender.
Donally, Richard S.	Sudbury.
Devine, William	Cook's Mills.
Durrill, William	Nosbonsing.
Draper, Patrick	Quyon, Que.
Davis, J. P.	Bobcaygeon.
Dale, John Alexander	Birkendale.
Dinsmore, Chas. L.	Huntsville.
Drum, Patrick	Belleville.
Durham, Edgar S.	Rosseau.
Duquette, Chas.	Webbwood.
Davis, William Albert	Bobcaygeon.
Dickson, Robert Alexander	Keene.
Dawkins, John	Gravenhurst.
Doxsee, James E.	Gravenhurst.
Didier, L. P.	Aylmer, Que.
Devine, Patrick J.	Sheenboro, Que.
Dinsmore, Richard	Huntsville.
Dunn, Percy E.	Longford Mills.
Duval, Chas.	Halfway.
Donlevy, James	Calabogie.
Doris, Patrick	Peterborough.
Doris, John	Peterborough.
Donahue, Michael	Erinsville.
Doran, W.	Belleville.
Dickson, Robert R.	Kippewa, Que.
Donlevy, Wm. C.	Rockcliffe.
Duff, Chas. A.	Stewartville.
Dean, James C.	Kenora.
Duff, Peter A.	Claybank.
Duncan, Downey	Rainy River.
Dougherty, J. M.	Fort Frances.
Dunn, John F.	Spanish Mills.
Dyke, Morris F.	Blind River.
Devitt, Frank	Dinorwic.
Dickie, David	Port Arthur.
Dupuis, Alfred	Keewatin.
Devlin, Samuel	Spanish Mills.
Dougherty, W. H.	McLaren's Bay.
Duffy, William A.	Callender.
Duncan, Edward J.	Sturgeon Falls.
Dennie, Frank	Capreol.
Dempsey, James	Pulp Siding.
Enlaw, Oliver	Campbellford.
Ebert, Andrew P.	Pembroke.
Ellis, Alexander	Arnprior.
Ellis, John	Westmeath.
Errington, Joseph	Sundridge.
Eddington, Henry John	Parry Sound.
Enright, Daniel	Port Arthur.
Eager, James	Parry Sound.
Elliott, Porter P.	Mine Centre.
Elliott, William	Cache Bay.
Edgar, J. E.	Kenora.
Elliott, George E.	Peterborough.
Edwards, Joseph K.	Gillies Depot.
Eldridge, Robert	Fort Frances.
Fraser, John A.	Kenora.
Ferguson, Wm. H.	Red Bay.
Forbes, Chris. McKay	McLean's Depot.
Fitzgerald, E. Clair	Parry Sound.
Farrell, W. H.	Ironside, Que.
French, Lewis William	Wisawasa.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Fraser, William A.	Mattawa.
Finerty, Patrick	Rochfort.
Farnand, Frank	Diamond.
Fulton, Philip S.	Spanish Station.
Fitzgerald, Ullyot C.	Parry Sound.
Fenn, George	Bracebridge.
Fortune, Owen	Trenton.
Fraser, David	Norman.
France, John	Collin's Inlet.
Ferguson, Ernest A.	Baysville.
Ferguson, Alpen	Mattawa.
Ford, John William B.	P'r'tage du Ft.,Q.
Ford, Charles	Wahnapitae.
Findlay, J. H.	Braeside.
Fraser, James	Renfrew.
Fairen, Francis	Peterborough.
Faulkner, Jos.	Fesserton.
Fraser, Alexander, Jr.	Westmeath.
Fairbairn, William	Calabogie.
Fraser, William A.	Pembroke.
Fraser, Foster	Pembroke.
Fraser, Wm.	Little Current.
Fraser, Hugh Alexander	Fembroke.
Flaherty, John	Lindsay.
Fisher, Wm.	Trenton.
Fox, Thomas	Deseronto.
Fallis, James W.	Sturgeon Bay.
Fairbairn, N. H.	Webbwood.
Friel, John	Trenton.
Fox, Charles	Trenton.
Featherstonehaugh, W. H.	Penetanguishene.
Friar, Schuyler	Westmeath.
Farren, Joel	Savanne.
Fraser, Duncan	Big Forks.
Freestone, Walter	Burk's Falls.
Fraser, John	Bancroft.
Fitzgerald, D. C.	Spanish Station.
Foster, Wm. C.	Searchmont.
Frazer, Jas. C.	Spanish Mills.
Fremlin, H. P.	Richard's Land'g.
Foster, Ed. G.	Sault Ste. Marie.
Farrel, Peter M.	Whitefish.
Fairhall, Edward	Whiteside.
Fraser, Levi	Bracebridge.
Fiddes, James	Rainy River.
Frawley, Frank	Orillia.
Fisher, George	Sault Ste. Marie.
Filiatrault, J. A.	Blind River.
Farrier, John William	Chapeau.
Finney, Benjamin B.	Fort Frances.
Follis, Frank C.	Hawkesbury.
Fortune, Percy H.	Blind River.
Fraser, Wm. Foster	Sault Ste. Marie.
Fraser, Allan, H.	Thessalon.
Farquharson, James	Tomiko.
Fink, John	Mattawa.
Fletcher, Nicol B.	Parry Sound.
Fraser, Darlington	Pembroke.
Faulkner, Wm.	Dryden.
Griffith, Geo. F.	Pembroke.
Graham, John	Arnprior.
Golden, John	Gilmour.
Gunter, Henry M.	Trenton.
Goltz, Ernest	Bardsville.
Green, Forman A.	Gilmour.
Green, Samuel E.	Parry Sound.
Grant, John	Flinton.
Green, Arthur	Ottawa.
Green, Norman McL.	Bancroft.
Gillis, John J.	Whitefish.
George, R. W.	Parry Sound.
Gardiner, John	Parry Sound.
Golden, Frank J.	Trenton.
Garson, Robert	Thessalon.
Gropp, August	Penetanguishene.
Grozelle, Antoine D.	Muskoka Mills.
Goulais, James	Peterborough.
Grayson, Charles	Keewatin.
Gladstone, Harry E.	Cook's Mills.
Guertin, Oliver	Biscotasing.
Gelinas, Frank	Hull, Que.
Gwynne, John	Hawkesbury.
Gray, Frederick M.	Brule Lake.
Graham, Edward G.	Wahnapitae.
Griffin, James	Spanish River.
Gordon, Alexander B.	Pembroke.
Gareau, Noah J.	Pembroke.
Gillies, D. A.	Carleton Place.
Gilligan, Edward	Mattawa.
Gladman, Charles	Parry Sound.
Garrow, John D.	Ottawa.
German, William Burton	Wahnapitae.
Gordon, Robert W.	Pembroke.
Guertin, Nelson	Petawawa.
Gardner, John	Kenora.
Gunter, Peter M.	Gilmour.
Glennie, William	Millbridge.
German, Maurice J.	Fenelon Falls.
Gillies, John A.	Braeside.
Goddin, Edward	Griffith.
Grant, Joseph	Eganville.
Gilmour, James B.	Braeside.
Gorman, Joseph P.	Sault Ste. Marie.
Gordon, Thomas A.	Hall's Bridge.
Gray, Albert H.	Biscotasing.
Gadway, John	Parry Sound.
Garrow, Edward	Webbwood.
Golding, William	Dorset.
Gillies, Harry	White Lake.
Gordon, Herbert C.	Nelson.
Gillespie, M. H.	Cook's Mills.
Griffin, William	Huntsville.
Ganton, David	Trout Creek.
Graham, George L.	Arnprior.
Graham, Frederick S.	Arnprior.
Gill, Cuthbert	Orillia.
Graham, James Robert	Kenora.
Graham, Thomas Jordan	Byng Inlet.
Gaudaur, Antoine Daniel	Orillia.
Gorman, Patrick	Eganville.
Guy, Charles	Fort Frances.
Graham, George H.	Gillies Depot.
Greer, George P.	Port Arthur.
Gill, Charles	Fort Frances.
Gamey, William H.	Englehart.
Gorman, Michael J.	Diver.
Grier, Roy B.	Kenora.
Greer, Samuel H.	Gore Bay.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Gilbert, Sidney N.	Rainy River.
Guilbeault, A. T.	Klock's Mills.
Gordon, J. B.	Cache Bay.
Gorman, Bert	Kenney Siding.
Hale, Thomas	Pembroke.
Hogan, Albert J.	Sault Ste. Marie.
Hagen, Edmund G.	Little Rapids.
Hagen, Wilson	Thessalon.
Hurd, Cyrus	Parry Sound.
Henderson, Albert E.	Burford.
Hale, John B.	Sault Ste. Marie.
Hickerson, Melvin T.	Fort Frances.
Howey, George H.	Fort Frances.
Hartt, James	Gilmour.
Hayes, James	Enterprise.
Humphrey, T. W.	Gravenhurst.
Huckson, A. H.	French River.
Handley, Robert	Douglas.
Howe, Alexander	Queensboro.
Hurd, Edwin	Hurdville.
Huff, J. S. Morris	Arnprior.
Halliday, Robert J.	Lindsay.
Hutton, John	Hutton House.
Hutchinson, Wm. E.	Huntsville.
Hogarth, Joseph Rowan	Pembroke.
Humphrey, John	Gravenhurst.
Hill, Joshua	Midland.
Hall, David	Lovering.
Hartley, Charles	Peterborough.
Hawkins, Henry Chas.	Blind River.
Hines, Philip Wallace	Huntsville.
Hudson, John Lewis	Combermere.
Hurdman, William H.	Ottawa.
Hughes, John	North Bay.
Howie, R. G.	New Liskeard.
Helferty, Dennis	Eganville.
Hamilton, Robert	Kenora.
Hoppins, Abiram	Kingston.
Hoppins, Densmore	Kingston.
Haystead, John	Parry Sound.
Henderson, John Irwin	Bobcaygeon.
Hartley, William	Millbridge.
Higgins, John C.	Peterborough.
Harrison, John, Jr.	Pembroke.
Hawkins, E.	La Breton Flats.
Henderson, Charles	Bracebridge.
Halliday, Frank	Parry Sound.
Hammond, W.	Orillia.
Hall, Charles Asa	Penetanguishene.
Hearl, John	Callender.
Howe, Isaac	Fort Frances.
Halliday, James	Springtown.
Hurdman, J. A.	Ottawa.
Hawkins, Stonewall J.	Meldrum Bay.
Hinchcliffe, William	Gunter.
Henderson, Arthur	Baysville.
Hillis, James M.	Sutton West.
Harris, Wm., Jr.	Day Mills.
Hogg, W. J.	North Bay.
Hoxie, E. P.	Katrine.
Hawkins, Walter	Pembroke.
Howard, James	Eganville.
Howard, William	Baysville.
Hogan, Enos W.	Savanne.
Horne, John T.	Fort William.
Hamilton, Chas. E.	Kenora.
Henderson, Leonard	Baysville.
Hunter, Thos.	Callender.
Hamilton, Robert J.	Ottawa.
Hawkins, William A.	Pembroke.
Herring, Edward C.	Sebright.
Hatch, J. W.	Dryden.
Hoard, Wm. Paris	Emo.
Hartman, W. R.	Blind River.
Hill, Ernest L.	Hawkesbury.
Hall, Samuel S.	Marmora.
Hasleton, Constantine	Killaloe.
Hamilton, A. J.	Spragge.
Heggart, E. C.	Trout Mills.
Hunt, Ronald E.	Massey.
Hurd, Asahel	Parry Sound.
Howe, Peter	Fort Frances.
Hammond, Samuel H.	Fort Frances.
Hunt, Alex. D.	Pearl River.
Home, John F.	Keewatin.
Hay, Benjamin	Port Arthur.
Hogan, John	Savanne.
Hargis, Thomas	Port Arthur.
Hartt, I. B.	Orillia.
Harkins, J. J.	Keewatin.
Hammond, Henry	Dryden.
Hyne, Geo.	Port Arthur.
Irving, Thos. H.	Parry Sound.
Irwin, Eli	Kenora.
Irving, Edward C.	Kenora.
Johnston, Ralph E.	Port Arthur.
Johns, Frank A.	Toronto.
Jackson, Robert	Brechin.
Johnson, Finlay	Bracebridge.
Jores, Albert	Victoria Harbor.
Johnson, Thomas	Bobcaygeon.
Johnston, Archibald M.	Norman.
Julien, Charles	Trenton.
Junkin, Henry	Marmora.
Johns, Frank	Nipiss'g Junct'n.
Jessup, Edward D.	Cache Bay.
Johnson, Frank N.	Ottawa.
Johnston, John	Peninsular Lake.
Johnson, S. M.	Arnprior.
Jones, Frederick James	Flinton.
Johnston, William A.	Castleford.
Jervis, Henry	Wisawasa.
Jones, William	Fenelon Falls.
James, Martin	The Flats.
Johnston, James	Fort Frances.
Johns, Alexander	Callender.
Jackson, John A.	Barwick.
Johnson, Thomas	Fort Frances.
Johnston, George N.	North Bay.
Jamieson, John	Fort Frances.
Jones, Wellard	Ignace.
Kintree, Stuart	Little Rapids.
Kerby, John	Belleville.
Kennedy, Robert	Marmora.
Kirby, Louis Russell	Ottawa.
Kennedy, Timothy	Enterprise.
Kirk, Henry	Trenton.
Knox, Milton	Ottawa.
Kinsella, Michael Pierce	Trenton.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Kitchen, D.	French River.
Kelly, Jeremiah	Sudbury.
Kelly, Ferdinand	Mattawa.
Kennedy, T. J.	Arnprior.
Kenning, Henry	Pembroke.
Kirby, D. F.	Belleville.
Kirkpatrick, David	Lindsay.
Kean, John F.	Orillia.
Kellett, Fred.	Keewatin.
Kelly, Michael J.	Baysville.
Kirk, William James	Webbwood.
Kerr, E. G.	Thessalon.
King, Napoleon	Mattawa.
Kemp, Orval Wesley	Trenton.
Kirk, Charles Barron	Queensborough.
Kingsland, W. P.	Ottawa.
Kerr, John B.	Arnprior.
Kennedy, Walter	Arnprior.
Kennedy, John	Pembroke.
Knox, Wm. M.	Fesserton.
Kingston, Robert	Wisawasa.
Kearnan, Robert	Blind River.
Kearney, Michael John	Buckingham, Qu.
Kendrick, John	Burk's Falls.
Kendrick, John L.	Burk's Falls.
Kennedy, John W.	Ottawa.
Kelly, James F.	Trout Creek.
Kauffman, Julias	Blind River.
Kennedy, Sylvester	Brule Lake.
Kernahan, George A.	Barwick.
Kehoe, Martin	Huntsville.
Kennedy, Daniel J.	Spanish.
Kay, Arthur	Norman.
Kennedy, Frederick J.	Buckingham, Qu.
Leannoth, Francis	Arnprior.
Lee, James	Warren.
Lloyd, Alfred	Severn Bridge.
Lawrie, Frank A.	Parry Sound.
Latimer, Jas.	Frank's Bay.
Lemyre, Middey	Campbellford.
Lutz, Jacob	Parry Sound.
Luby, John E.	Ottawa.
Law, Wm. J.	Markstay.
Lummis, Daniel	Glanmire.
Lowe, W. C.	Port Arthur.
Londry, S. C.	Sault Ste. Marie.
Lochnan, James	Ottawa.
Link, Henry W.	Ottawa.
Ladarotte, John	Arnprior.
Lochnan, John	Aylmer, Que.
Lozo, John	Trenton.
Loughrin, Lawrence	Pembroke.
Linton, J. H.	Parry Sound.
Ludgate, James	Peterborough.
Lee, Robert	Huntsville.
Langford, Mark	Baysville.
Letherby, Edwin	Midland.
Leahy, Francis M.	Chapeau, Que.
Langford, Henry	Baysville.
Lessard, Philip	Kenora.
Lovering, William James	Coldwater.
Lane, Maurice	Bobcaygeon.
Lenton, George	Peterborough.

Lowe, Thomas A.	Renfrew.
Livingston, Robert M.	Huntsville.
Londry, William E.	Sault Ste. Marie.
Labelle, James	Waltham, Que.
Labelle, Eli	Waltham, Que.
Ladurante, J. D.	Ottawa.
Ludgate, Theodore	Peterborough.
Lucas, Frank	Sault Ste. Marie.
Lunam, Duncan	Collfield, Que.
Lott, George	Trenton.
Lawrie, John D.	Parry Sound.
Lovering, George Francis	Coldwater.
Lucas, R. G.	Christina.
LeBlanc, Edmund C.	Chapleau.
Lavigne, John	Aylmer, Que.
Landell, Charles S.	Huntsville.
Long, Henry Elisha	Mattawa.
Lynch, W. H.	Collingwood.
Laplante, Francis	Byng Inlet.
Lindsay, James	Arnprior.
Labelle, Michael	Arnprior.
Legree, John	Dacre.
Legree, James L.	Calabogie.
Leigh, John Chas.	Gravenhurst.
Lloyd, Edward B.	King.
Lemyre, Bruno	Gravenhurst.
Lavelle, Charles H.	Canoe Lake.
Lyons, James	Waltham Sta., Q.
Ledwood, Charles	Ottawa.
Levelle, Emrey	Waltham Sta., Q.
Little, Theo.	Kenora.
Lehman, Joseph	Stratton Station.
Lafare, Mark	Cache Bay.
Leach, George	Vermilion Bay.
Lott, Angus M.	Spanish Mills.
La Belle, Ambrose	Kenora.
La Breen, Douglas	Kenora.
Lavelle, Michael J.	Blind River.
Lyleton, J. E.	Parry Sound.
Lalor, William J.	Aspdin.
Lalonde, Joseph Maxine	Lirk.
Laderoute, Michael	Arnprior.
Leroy, Levi H.	Port Arthur.
Lusigneau, Arthur	Pembroke.
Link, John	Link P.O.
Love, B.	Port Arthur.
Landry, Fred. S.	Sturgeon Falls.
Malloy, Mark	Baysville.
Martin, Hugh	Sault Ste. Marie.
Miller, R. C.	Gravenhurst.
Morrison, James	Toronto.
Murray, Frederick	Huntsville.
Menzies, Archibald	Burk's Falls.
Manning, James	Trenton.
Martin, Philip	Stoco.
Malone, Wm. Patrick	Ottawa.
Marsh, Esli Terrill	Trenton.
Miller, John W.	Huntsville.
Muchinbacker, Asa	Rousseau Falls.
Morris, Geo. F.	French Bay.
Murray, George, Jr.	Waubaushene.
Maughan, Joseph	Fort William.
Margach, Wm. J.	Port Arthur.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Murray, George, Sr.	Waubaushene.
Manice, Wm.	Peterborough.
Murray, Wm.	Kenora.
Morgan, Richard J.	Kenora.
Magee, Thomas Arthur	Kenora.
Murdoch, James	Cook's Mills.
Mulvahill, Wm.	Arnprior.
Murphy, Arthur	Ottawa.
Mayhew, Jacob	Northcote.
Molyneaux, George	Parry Sound.
Milway, Joseph	Fort William.
Mackie, Nathan	Port Arthur.
Milne, Archie	Arnprior.
Murray, James	Peterborough.
Moore, James A. E.	Lakefield.
Merkley, William A.	Ottawa.
Murphy, Hugh R.	Ottawa East.
Murphy, W. J.	Arnprior.
Murray, William	Markstay.
Martin, Edgerton	Markstay.
Mathieson, Archie	Fort Frances.
Moore, Henry R.	Lakefield.
Mickle, Chas. S.	Gravenhurst.
Mullen, James	Webbwood.
Morley, A. W.	Winnipeg.
Macdonald, James M.	North Bay.
Money, Harry	Haileybury.
Mather, Allen	Keewatin.
Menzies, Alexander	Sault Ste. Marie.
Munro, Peter P.	Commanda.
Mason, Benjamin	Westmeath.
Monaghan, John B.	Arnprior.
Monaghan, M. J.	Arnprior.
Mulvihill, John	Arnprior.
Moran, Andrew	Rockingham, Qu.
Mulvihill, Michael	Arnprior.
Mann, John	Manitowaning.
Marrigan, Richard	Deseronto.
Monaghan, John Dorland	Deseronto.
Matheson, Wm.	Chelmsford.
Munro, Alex. G.	Braeside.
Murphy, Oliver A.	Marksville.
Mellor, Charles	Port Arthur.
Millions, Harry	Gillies Depot.
MacDonell, R. D.	Biscotasing.
Milne, Fred.	Trout Mills.
Milne, William H., Jr.	North Bay.
Murphy, Dennis	Thessalon.
Mackie, Thomas	North Lake.
Miller, P. H.	Blind River.
Munro, Philip	Braeside.
Mangan, Patrick	Arnprior.
Marcil, Peter	Ottawa.
Main, Samuel	Spanish Station.
Morley, Charles	Huntsville.
Moore, David Henry	Peterborough.
Murphy, John	Arnprior.
Mathieson, Daniel	Chelmsford.
Milne, Wm.	Ethel.
Mangan, Charles	Burk's Falls.
Mooney, Lincoln	Orillia.
Mangan, John	Arnprior.
Mooney, Thomas	Kingston.
Mason, Robt. T.	Rochesterville.
Moore, Wm. John	Gravenhurst.
Morrison, Donald	Reay.
Moore, Wm.	Bobcaygeon.
Mutchenbacker, Herman	Rosseau Falls.
Moore, Norman	Arnprior.
Morley, John R.	Kenora.
Mackay, J. A.	Big Forks.
Miller, Robt.	Montreal.
Mackey, Levi Ralph	Keewatin.
Morley, Frank W.	Kenora.
Madden, F. M.	Haileybury.
Miller, Walter E.	Owen Sound.
Murray, Robt.	Berriedale.
Mills, W. J.	Cache Bay.
Martin, Oscar	Buckingham, Que
Margach, Jas. A.	Kenora.
Murray, Peter	Emo.
Macdermid, Harry	Sellwood Jct.
Muckle, John	Keewatin.
Morel, H., Jr.	Mattawa.
Molyneaux, Harold	Parry Sound.
Marchildon, J. P.	Sturgeon Falls.
Main, G. C.	Fort Frances.
Marr, H. J.	Superior Jct.
Mathewson, O. R.	Blind River.
Morel, Adage	Mattawa.
McCaw, Joseph E.	Tweed.
McLaren, Peter	Kenora.
McGregor, Colin F.	Kenora.
McKenzie, Robt.	Kenora.
McFadyen, A. J.	Bracebridge.
McCaulay, Thos. J.	Goulais Bay.
McDonald, John C.	Spanish Mills.
McKenzie, Alex. E.	Ansonia.
McIntyre, John	Arnprior.
McDermott, Thos.	Orillia.
McDermott, Jas. E.	North Bay.
McCrindle, Jas.	Sudbury.
McGhie, Chas. S.	Whitestone.
McGenigal, John H.	Whitby.
McCart, Patrick	Arnprior.
McGrath, Thos. B.	Peterborough.
McCormick, James J.	Trenton.
McCarthy, Wm.	Fenelon Falls.
McAvoy, Owen	Campbellford.
McConnell, Lewis	Fesserton.
McMullen, George	Spragge.
McNab, Angus	Burnstown.
McColgan, C. H.	Quyon, Que.
McCallum, Webster	Arnprior.
McFarlane, Robert L.	Warren.
McCagherty, Robert E.	Westmeath.
McNab, Archie	Calabogie.
McDonald, Malcolm	Spragge.
McIvor, J. A.	Fort Frances.
McCulloch, M.	Kenora.
McDonagh, Rod.	Callender.
McManus, James	Arnprior.
McKinley, J. H.	Curran.
McPherson, Jas. S.	Rama.
McKinley, Edward C.	Toronto.
McClelland, John	Parry Sound.
McFarlane, J. W.	Cache Bay.
McDonald, Roderick	Pembroke.
McCormack, Wm.	Pembroke.
McCreary, William	Arnprior.
McCuaig, James C.	Bryson.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

McColman, Peter	North Bay.
McLeod, James D.	Gravenhurst.
McCrimmon, N. K.	Blind River.
McCreary, James, Jr.	Arnprior.
McPhee, Hugh	Byng Inlet.
McCudden, James	Arnprior.
McLachlin, J. A.	Arnprior.
Macpherson, John	Ottawa.
McEachren, John A.	Gravenhurst W.
McLeod, Dugald	Gravenhurst.
McClelland, R. H.	Parry Sound.
McEvoy, Frank	Campbellford.
McDermott, Peter	Orillia.
McIlroy, John	Madoc.
McNab, Robert J.	Parry Sound.
McFadden, James	Ottawa.
McIntosh, James G.	Carleton Place.
McInnis, Hector D.	Bracebridge.
McKinnon, Malcolm	Bracebridge.
McLean, Daniel	Bracebridge.
McKinnon, Archie J.	Bracebridge.
McKay, D. C.	Baysville.
McDonald, James	Parry Sound.
McPherson, Allan	Longford.
McDonald, James P.	French River.
McFarlane, Jos. C.	Port Severn.
McNabb, Alexander	Thessalon.
McGillivray, Archibald	Port Arthur.
McGrane, Edward	Lindsay.
McLeod, Donald, Jr.	Keewatin.
McDonald, Hector R.	Thessalon.
McDougall, Duncan	Bracebridge.
McNabb, Alexander D.	Warren.
McCormack, John C.	Sudbury.
McNamara, John	Byng Inlet.
McGillivray, Duncan D.	Algoma Mills.
McIntyre, Daniel A.	Klock's Mills.
McNamara, Lewis	Klock's Mills.
McDonald, Sydney C.	Mattawa.
McGurn, John J.	Buckingham, Qu.
McKeown, Jno. Joseph	Port Arthur.
McNeel, David	Sault Ste. Marie.
McEwan, Andrew	Thessalon.
McCool, Christopher L.	Cartier.
McCollom, Donald	Arnprior.
McDowell, Wm.	Cache Bay.
McConnachie, Roy Stewart	Huntsville.
McDonnell, J. K.	Kenora.
McDonald, Alex. J.	Vermilion Bay.
McKay, D. A.	Rainy River.
McMillan, James	Kenora.
McPhee, Ronald	Bracebridge.
McKay, George Donner	Dorset.
McWilliams, Maxwell Theodore	Peterborough.
McLeod, John	Keewatin.
McPherson, George	Keewatin.
McDougall, John D.	Kenora.
McGregor, Duncan	Burnstown.
McLean, Peter W.	Sand Point.
McNichol, John	Sudbury.
McInnis, D. E.	Cache Bay.
McLaughlin, Samuel	Waubaushene.
McCollam, John	North Bay.
McManus, John C.	Arnprior.
McLean, John	Blind River.
McLeod, Norman	Garden River.
McLean, James	Blind River.
McNally, J. A.	Desbarats.
McNab, Alexander	Arnprior.
McFarlane, Alexander	Renfrew.
McFarlane, J. D.	Stewartsville.
McFarlane, Duncan	Renfrew.
McKendry, Wm. B.	Arnprior.
McPhee, Hugh	Renfrew.
McPhee, John	Arnprior.
McLachlin, Peter	Arnprior.
McLachlin, Alexander	Arnprior.
Mackey, Edward	Arnprior.
McEwan, Henry	Trenton.
McDonald, Alfred	Peterborough.
McGeary, John J.	Sundridge.
McDonald, Archibald W.	Gilmour.
McGaw, John Gillen	Queensborough.
McCauley, Barney	Trenton.
McDougall, James T.	Klock's Mills.
McInenly, Thomas	Quebec, Que.
McBride, Archibald	Arnprior.
McFarlane, Robert L.	Arnprior.
McGowan, Wm.	Parry Sound.
McLachlin, Norman	Arnprior.
McDonald, Laughlin	Pendleton.
McIvor, William J.	Collin's Inlet.
McKee, John P.	Sturgeon Falls.
McGowan, Thomas	Parry Sound.
McDermot, Patrick	South River.
McKay, Angus	South River.
McDonald, A. J.	Longford.
McInnis, Angus D.	Gravenhurst.
McKendry, Alexander	Waubaushene.
McGuire, Timothy	North Bay.
McGrath, John	Peterborough.
McWilliams, Jno. Bannon	Peterborough.
McCagherty, Patrick	Westmeath.
McKendry, Daniel	Arnprior.
MacDonald, D. F.	Parry Sound.
McManus, Thomas J.	Renfrew.
Macfarlane, David R.	Ottawa.
McColgan, Edward	Quyon, Que.
McKay, John	Emo.
McKinnon, William	Kenora.
McKittrick, Frank R. F.	Kenora.
McMichael, Charles	North Seguin.
McIlroy, Thomas David	Madoc.
McDonald, Wm. Henry	Trenton.
McGaw, Wm. Thomas	Callender.
McMillan, L.	Callender.
McDermott, John L.	Orillia.
McDonald, Chas. M.	Pembroke.
McPhee, Benjamin	Pembroke.
McGee, John Edward	Parry Sound.
Macfarlane, Mack	Arnprior.
MacCallum, Alexander	Braeside.
McRae, Farquhar	Kenora.
MacCallum, Albert	Arnprior.
McGonigal, John	Arnprior.
McConachie, John	Huntsville.
McKay, D. G.	Kenora.
McDonald, James	Peterborough.
McCulloch, John L.	Lonsdale.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

McConnell, James	Mine Centre.
McIntyre, William John	Port Arthur.
McDonald, Allen	Big Forks.
McLay, Albert	Devlin.
McQuarrie, Daniel	Fort Frances.
McNaughton, Daniel	Bracebridge.
McCagherty, William E.	Westmeath.
McDonald, John D.	Mattawa.
McCagherty, Joseph T.	Westmeath.
McAdam, Arch. H.	Quyon, Que.
McMurphy, Dugald, Jr.	Kenora.
McCall, Alfred	Kenora.
McRitchie, William	Kenora.
McRitchie, Malcolm	Kenora.
McDonald, John Harold	Rydal Bank.
McAuley, William Davis	Sault Ste. Marie.
McCallum, Thomas	Fort William.
McWhinney, Fred.	Kenora.
McNairney, Hugh H.	Sudbury.
McKelvie, William	Otter Lake Sta.
McGovern, Frank	Sault Ste. Marie.
McCallum, Gordon	Fort Frances.
McCallum, Henry	Fort Frances.
McLaughlin, Russell	Spanish Mills.
McAdam, Miner S.	Quio, Que.
McDougall, David A.	Nesterville.
McLeod, William A.	Manitowaning.
McKee, D. A.	Wylie.
McKay, Norman	Fort Frances.
McIntosh, Wm.	Biscotasing.
McMahon, Edwin	Nesto, P.O.
McGowan, Thos.	Parry Sound.
McDonald, Norman	Keewatin.
McLeod, John C.	Port Arthur.
McIntosh, Herbert	Biscotasing.
McDonald, Thos.	Kenora.
McCool, Daniel	Sudbury.
McDonald, Frank	Mattawa.
McLeod, E. H.	Nepigon.
Nescott, George	Kenora.
Newton, Frank	Gravenhurst.
Newburn, Wm.	Parry Sound.
Niblett, James	Arnprior.
Nisbett, Robert	Osceola.
Nevison, Herbert	Kenora.
Nicholson, John	Owen Sound.
Newall, John H.	Parry Harbour.
Nolan, John	Gravenhurst.
Newton, Charles W.	Victoria Harbour.
Nent, Charles	Vermilion Bay.
Needham, John G.	Pakenham.
Netterfield, David	John's Island.
Nault, James	Fort Frances.
Norgate, Chas.	Dryden.
Nash, John	Kenora.
Nesbitt, Thos.	Kenora.
Oullette, Joseph P.	Cutler.
O'Neil, Thomas	Bancroft.
O'Neill, Daniel H. H.	Arnprior.
O'Leary, Patrick J.	Orillia.
Oilver, Charles R.	Fesserton.
Overend, George J.	Longford Mills.
O'Brien, Andrew	Ottawa.
O'Brien, Frank G.	Arnprior.
Oliver, J. A.	Fort William.
Owen, W. J.	Wabigoon.
O'Connor, John	Hintonburg.
Oliver, Darcy	Wahnapitae.
O'Connor, Wm.	Norbonsing.
O'Neil, James W.	North Bay.
O'Donnell, Wm.	Penetanguishene.
Owens, Richard	Basin Depot.
O'Reilly, Patrick	Cartier.
O'Neill, Mark	Renfrew.
Orrill, John	Trenton.
O'Neill, Patrick	Bancroft.
Orde, Francis W.	Kenora.
O'Driscoll, Joseph	Sault Ste. Marie.
O'Gorman, Peter	Blind River.
Ogden, L. M.	Fort Frances.
Pigott, John	Fitzroy Harbour.
Paul, Charles A.	Sault Ste. Marie.
Patinson, Thos.	Bracebridge.
Price, A. E.	Arnprior.
Presley, J. F.	Ashton.
Power, James	Bobcaygeon.
Patzel, Adolph	Arnprior.
Plaunt, William B.	Eganville.
Plaunt, Joseph	Eganville.
Porter, Charles C.	Longford.
Preston, R. E.	Kenora.
Petrie, Geo. A.	Fergus.
Pomeroy, Peter	Trenton.
Perry, Pringle K.	Byng Inlet, N'th.
Purcall, W. G.	Ottawa.
Purvis, John	Parry Sound.
Porter, James	Uphill.
Pearson, John James	Lindsay.
Penney, Chas. G.	Cache Bay.
Pennock, James P.	Hardwood Lake.
Purdy, John A.	Uxbridge.
Playfair, R. J.	Blind River.
Paterson, John	Wahnapitae.
Paterson, Alexander	Orillia.
Parke, James	Gravenhurst.
Parquette, Oliver	Webbwood.
Palmateer, Sherman	Gravenhurst.
Paget, George	Huntsville.
Pounder, Joseph	Westmeath.
Pell, Richard D.	Arnprior.
Perry, Frederick	Port Arthur.
Paget, Charles Edward	Novar.
Porter, Thos. Robt. Mark	Dorset.
Pountney, E. J.	Arnprior
Pyburn, David J.	Dorset.
Purdy, Geo.	Hintonburg.
Playfair, Andrew Wm.	Sault Ste. Marie.
Pipe, Taylor	Haileybury.
Pipher, George E.	Mowat.
Pendee, David	Parry Sound.
Piper, A. J.	Blind River.
Paget, Alfred H.	Ahmic Harbour.
Powers, John J.	Trout Mills.
Pigott, William D.	Fitzroy Harbour.
Potts, Cyril	North Lake.
Pilkey, William	La Vallee.
Pointer, Roy R.	Pembroke.
Piper, Roy	Blind River.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Pehill, Walter	Dryden.
Palmer, Fred.	Blind River.
Quinn, William	Peterborough.
Quigley, Hugh	Penetang.
Quirk, Thomas J.	Petawawa.
Quance, Louis F.	Berriedale.
Robertson, D.	Kenora.
Richardson, Fred'k George	Trenton.
Richards, Richard	Tamworth.
Riddell, Geo. Alexander	Rochesterville.
Robertson, Lewis McLean	Dunchurch.
Robinson, Wm. F.	Bobcaygeon.
Reamsbottom, Wm.	Mattawa.
Richey, Evan	Brentwood.
Randall, Lewis G.	French River.
Richardson, Chas. Marvyn	Trenton.
Rochester, Daniel Baillie	Ottawa.
Riddell, James	Ottawa.
Rice, Asa S.	Hull, Que.
Roberts, T. A.	Huntsville.
Ross, Andrew	Longford Mills.
Rose, Donald M.	Kenora.
Rawson, Charles Edward	Coldwater.
Ross, George	Waubaushene.
Roberts, Percy T.	Keewatin.
Ritchie, Wm. D.	Little Current.
Ramsay, Robert	Arnprior.
Ritchie, J. F.	Arnprior.
Ritter, Samuel G.	Ahmic Harbour.
Rothera, Charles F.	Sturgeon Falls.
Ryan, Alfred	Byng Inlet.
Rogers, Fred.	Sault Ste. Marie.
Reid, George William	Fort Frances.
Robertson, John A.	Kenora.
Robinson, Wm.	Bobcaygeon.
Reid, Joseph B.	Lindsay.
Ross, Walter M.	Ottawa.
Ruttle, H. A.	Carleton Place.
Richards, Benedict	Ottawa.
Regan, John	Orillia.
Russel, Wm.	Pembroke.
Ramsay, Charles	Sudbury.
Russell, Corsan L.	Pembroke.
Richards, Henry	Dacre.
Ryan, Wm.	Killaloe.
Reid, John P.	Spanish Mills.
Ridley, Robert	New Liskeard.
Riley, Charles W	Hutton House.
Raymond, Morris T.	Spanish Mills.
Rooney, Wm. H.	Campbellford.
Revell, J. O.	Dryden.
Rankin, Anthony	Cache Bay.
Ross, Angus	Orrville.
Robinson, Albert E.	Washago.
Robinson, Edward	Washago.
Robinson, Thomas G.	Washago.
Raycroft, William T.	Sarnia.
Roberts, Ivor M.	Garden River.
Revell, Lionel Oliver	W. Gravenhurst.
Regan, Judd Patrick	Orillia.
Robins, Etna Rosedale	Orillia.
Regan, John, Jr.	Orillia.
Ryan, James	Savanne.
Rusk, Oscar W.	Cache Bay.
Robinson, Thos. Geo.	Bracebridge.
Rooksby, Wm.	Campbellford.
Ramesbottom, Robt.	Byng Inlet.
Roy, Lewis	Arnprior.
Riddell, Horace A.	Galetta.
Rowan, A. L.	Sault Ste. Marie.
Ritchie, James A.	Spragge.
Ross, George Joseph	Schreiber.
Rowe, Frank E.	Hymers.
Regmibal, J. Hector	Larchwood.
Reid, William T.	Fort Frances.
Ross, Sidney	Fort William.
Robinson, Thos.	Kenora.
Robertson, J. D.	Kenora.
Richardson, C. R.	Fort Frances.
Richey, A. W.	Sudbury.
Robinson, W. J.	Dryden.
Smith, M. D.	Fort William.
Scanlan, William	Enterprise.
Sutherland, D. H.	Gravenhurst.
Spanner, John	Huntsville.
Shier, James D.	Bracebridge.
Spooner, W. R.	Katrine.
Simpson, Alfred E.	Wakefield.
Souliere, John B.	Ottawa.
Shields, James A.	Carleton Place.
Spargo, George	Ottawa.
Smyth, W. H.	Baysville.
Salmon, R. H.	Byng Inlet North.
Salmon, Alexander C.	Baysville.
Stremer, A.	Ottawa.
Shields, Frank A.	Parry Sound.
Stapleton, John J.	Ogidakie.
Sloan, William H.	Fort Frances.
Smyth, Job E.	Cache Bay.
Sage, Nelson	Muskoka Mills.
Seymour, Edward	Whitefish.
Shaw, Thomas B.	Waubaushene.
Swanston, James	Peterborough.
Simpson, William	Hall's Bridge.
Sadler, Thomas	Lindsay.
Smith, Patrick Albert	Norman.
Snaith, William J.	Mattawa.
Sinn, William F.	Arnprior.
Sheppard Wm. Joseph	Waubaushene.
Spears, Milton B.	Barry's Bay.
Stevenson, Arthur	Peterborough.
Stein, Paul	Sault Ste. Marie.
Shaw, Alfred	Thessalon.
Sequin, Napoleon	Spanish Station.
Scrim, Robert	Arnprior.
Sharp, James A.	Sudbury.
Shaneay, Harry S.	Cook's Mills.
Smith, Wm.	Ottawa.
Stewart, Daniel	Braeside.
Sheehan, Michael H.	Waubaushene.
Smith, Sydney H.	Bracebridge.
Stewart, James A.	Pembroke.
Sproule, Newton H.	Schomberg.
Simmons, Alex.	Port Arthur.
Scott, Thomas	Parry Sound.
Smith, Lawrence	W. Saginaw. Mich
Shea, Stewart	Campbellford.
Sullivan, John	Sault Ste. Marie.

Appendix No. 12.—Continued.

LIST OF CULLERS.—*Continued.*

Sinclair, Finlay	Sudbury.
Shiels, Henry F.	Cartier.
Smith, Gideon Ousley	Burk's Falls.
Smith, John Wallis	Thedford.
Smith, Henry G.	Arnprior.
Story, John A.	Ottawa.
Sweezy, Benjamin	Massey.
Sheppard, Charles H.	Coldwater.
Seabrook, Alex.	Fabre P.O.
Spreadborough, Newlands	Little Current.
Sheffield, George	Chapleau.
Sanders, William J.	Sudbury.
Sinclair, Armon D.	Arnprior.
Smith, Sidney E.	Ottawa.
Sleeman, Wm.	Rapid River.
Sheehan, Peter F.	Loring (canc'l'd).
Sleeman, Geo.	Rapid River.
Sims, Wm. K.	Sault Ste. Marie.
Skahill, Wm.	Blind River.
Shaw, George	Thessalon.
Sarsfield, George Francis	Sault Ste. Marie.
Standish, Wm. H.	Batchawaning Bay.
Simpson, Wm. A.	Lakefield.
Scollard, Wm.	Young's Point.
Shuttleworth, Alma	Trout Creek.
Shanacy, Wm. J.	Spragge.
Seely, George	Arnprior.
Stewart, Alex. W.	Lanark.
Soreny, Wm.	Braeside.
Schneder, Frederick	Cache Bay.
Smith, James D.	Kenora.
Sullivan, James	Aylmer.
Scully, Cornelius	Whitney.
Savoy, Eutrope	North Bay.
Smith, Walter J.	Campbellford.
Seymour, John J.	Whitefish.
Smith, Alex. R. C.	Burk's Falls.
Stewart, Richard M.	Chelsea, Que.
Souliere, John H.	Canoe Lake.
Smith, Abraim G.	Quyon, Que.
Swallow, C. H.	Day Mills.
Strave, A. M.	Mine Centre.
Stewart, John	Fort Frances.
Sullivan, George L.	Rainy River.
Short, James	Kenora.
Shaw, Fred. Jason	Thessalon.
Short, Chas. J.	Kenora.
Smith, David H.	Sudbury.
St. Hillaire, George	Arnprior.
Souliere, Joseph C.	Cutler.
Scott, J. C.	Fort Frances.
Stewart, Frank E.	Crozier.
Sanders, Edward	Barwick.
Spence, William	Arnprior.
Scott, Allan A.	Norman.
Souliere, Max	Spanish Mills.
Stewart, David	Cache Bay.
Shaw, Donald	Keewatin.
Smyth, C. W.	Fort Frances.
Stewart, Jas. Max	Winnipeg, Man.
Stewart, Russell C.	Winnipeg, Man.
Sisson, Heber P.	Hymers.
Schultz, Albert	Pembroke.
Spavin, John	Westmeath.
Spense, Dalton	Parry Sound.
Sparling, S. W.	Richan.
Smith, L. G.	Worthington.
Skead, Eric S.	Spanish Mills.
Sullivan, Michael	Barry's Bay.
Swale, William	Gillies Depot.
Schreiber, C. C.	Sudbury.
Shirfield, Wm. Chas.	Dryden.
Taylor, Fred. L.	Parry Sound.
Thomas, Griff J.	Thessalon.
Thomson, R. D.	Biscotasing.
Tait, Thomas B.	Burk's Falls.
Taylor, C. M.	Gravenhurst.
Thornton, W. D.	Longford Mills.
Trussler, Gilbert	Trout Creek.
Thompson, Geo. S.	Lindsay.
Thompson, Fred. A. H.	Nosbonsing.
Thompson, Francis Hy.	Nosbonsing.
Train, A. C.	Rowan Mills.
Turgeon, Geo.	Cook's Mills.
Thayer, Wm.	Sault Ste. Marie.
Thompson, Alexander W.	Arnprior.
Taylor, Thos. G.	Gravenhurst.
Trowse, A.	Arnprior.
Tucker, Louis A.	Fort Frances.
Thompson, Daniel	P'rt'ge du F'rt, Q.
Thompson, Richard	Kenora.
Thompson, Joseph H.	Bracebridge.
Taylor, Edward A.	Westmeath.
Tait, Ralph	Arnprior.
Train, William	Burk's Falls.
Turner, Garvin F.	North Bay.
Tilson, Joseph	Burk's Falls.
Tuffy, John	Cartier.
Thorpe, Thomas	Pembroke.
Taylor, Charles E.	Gravenhurst.
Tench, Arthur	Hekkla.
Tulloch, William A.	Sault Ste. Marie
Taylor, Alex. M.	Burnstown.
Toner, J. A.	P'rt'ge du F'rt. Q.
Thrasher, Henry G.	Pembroke.
Tooke, Frank	Bala.
Thorburn, Donald James	Thessalon.
Tetreault, Philias	Tomiko.
Tibbets, L. R.	Fort Frances.
Tichborne, A. C.	Fort Frances.
Thomson, Donald	Arnprior.
Udy, Dean	French River.
Urquhart, Elias	Gravenhurst.
Urquhart, Andrew	Barrie.
Vigrass, Percy J.	Dufferin Bridge.
Vincent, Joseph	Warren.
Vollin, Samuel	Nosbonsing.
Vannier, Nelson Joseph	Bobcaygeon.
Vincent, James	Fesserton.
Vincent, Henry T.	Port Sidney.
Vanderburg, Norman	Wisawasa.
Valois, Armand	Mattawa.
Villiers, Claude	Parry Sound.
Vanier, John	Sault Ste. Marie.
White, Thomas S.	Bracebridge.
White, A. Thomson	Pembroke.
Watt, R. A.	Spanish.
Wilkins, Hughes	Blind River.

Appendix No. 12.—Concluded.

LIST OF CULLERS.—*Concluded.*

Wallace, T. William	Blind River.
White, Joseph W.	Bracebridge.
Watson, William	Huntsville.
Webb, George W.	Parry Sound.
Wilcox, Thomas	Parry Sound.
Wheeler, J. A. McL.	Tamworth.
Widdifield, C. H.	Pine Orchard.
Whitmore, Edgar	Rosseau Falls.
Wright, L. B.	Sault Ste. Marie.
Ward, Joseph W.	Ottawa.
Wilkinson, W.	French River.
Waldie, John E.	Victoria Harbour.
Wigg, Thomas G.	Thessalon.
Wall, Patrick B.	Cheboygan, Mich.
Wells, John R.	Little Current.
Whiteside, John	Huntsville.
Watt, William	Peterborough.
Wilson, George	Lindsay.
White, Thomas	Parry Sound.
Wood, William D.	Sault Ste. Marie.
Watts, John J.	Fort Frances.
Webster, George F.	Fort Frances.
Wright, Percy	Fort Frances.
Watts, William B.	Fort Frances.
Watson, William	North Bay.
Wagner, Fred.	Kenora.
Wainwright, Edward C.	Huntsville.
Wilson, Wm. James	Deseronto.
Weston, Frank R.	Midland.
White, James B.	Manitowaning.
Warren, Robert M.	Cache Bay.
Wilson, George A.	Balsam Hill.
Welch, Harold	Milberta.
Wilson, James A., Jr.	Webbwood.
Woods, John R.	Antrim.
Wardell, Ernest C. S.	Victoria Harbour.
Woods, Joseph F.	Roach's Point.
Whaley, Thomas	Huntsville.
Webster, Wm. Alfred	Bracebridge.
Wornsdorf, Fred. Gutlep	Pembroke.
Warrell, Wm.	Trout Creek.
Wims, Peter	Blessington.
Wickware, Philip Almont	Cloyne.
Wilson, Edward	Deseronto.
Whelan, P. J.	McDougall.
Whyte, John, Thos. Goth	Ottawa.
Watterworth, J. A.	Sault Ste. Marie.
White, Wm. James	Muskoka Falls.
Warrell, George	Powassan.
Wells, George W.	Little Current.
Wilson, Frederick Gould	Kenora.
Wallace, John Thomas	Thessalon.
Wilkins, George N.	Baysville.
Wylie, Byron M.	Webbwood.
White, Allan	Pembroke.
Warner, Franklin H.	Fort Frances.
Watts, George	Fort Frances.
Wood, Thomas	Parry Sound.
White, William	Peterborough.
Woods, A. L.	Kenora.
White, John B.	Kippewa, Que.
Whelan, Peter M.	Renfrew.
Wilson, David	Kearney.
Weston, Cecil	Dorset.
Wilkins, George E.	Dorset.
Woodcock, Edward	Brownhill.
Wilson, Fred.	Callender.
Wilson, Alexander R.	Thessalon.
Webster, Henry R.	North Lake.
Wallace, Fred. R.	Port Arthur.
Wallace, Clayton	Blind River.
Wilson, Russell	Pembroke.
Wheeler, George	Barwick.
Wall, G. L.	La Vallee.
Williams, Edward R.	Port Arthur.
Whalen, Jos.	Pembroke.
Wood, W. G. A.	Porcupine.
Younge, Harvey D.	Fort Frances.
Young, R. H.	Fort Frances.
Yuill, John Albert	Braeside.
Young, William	Severn Bridge.
Young, A. J.	Cache Bay.
Young, Samuel	Coldwater.
Young, Patrick P.	Young's Point.
Young, Francis G.	Young's Point.
Yuill, Thomas	Arnprior.
Yuill, A. D.	Braeside.
Young, C. T.	Harvey.
Yuill, John Alex.	Arnprior.
Yuill, Archibald	Bracebridge.
Yuill, William	Braeside.
Young, Walter D	Whitefish.

Appendix No. 13.

RECORDS BRANCH, 1916-17.

Communications Received:

From Crown Land Agents	7,642
" Mining Recorders	3,602
" Crown Timber Agents	3,566
" Homestead Inspectors	1,391
" Fire Rangers	2,666
" Superintendent, Algonquin Park	403
" Superintendent, Quetico Park	127
Orders-in-Council	191
Telegrams	224
Nickel Commission (letters)	1,025
Northern Development Branch	5,699
Colonization Branch	7,244
Loan Commissioner	6,532
Mining Commissioner	2,016
Forestry Branch (direct)	2,151
Mine Assessor	2,057
Mine Inspector	801
Provincial Geologist	625
All other sources	31,637
Total pieces, incoming (Minister's office excluded)	79,599

Communications Sent Out:

To Crown Agents, Inspectors, Rangers and Park Superintendents	20,063
To general public	20,890
Circular letters (timber sales)	1,620
Maps and blue prints	2,803
Mining Reports to foreign countries	295
Mining Acts	1,415
Nickel Commission (letters)	1,016
Nickel Commission (reports—home and foreign)	2,300
Northern Development Branch (letters)	5,442
Northern Development Branch (seed grain)	967
Colonization Branch (letters)	7,680
Colonization Branch (books, maps and calendars)	68,987
Loan Commissioner	6,740
Mining Commissioner	3,614
Forestry Branch (including circular letters)	7,503
Mine Assessor	2,050
Mine Inspector (letters)	871
Mine Inspector (reports, etc.)	104
Provincial Geologist (including circular letters)	991
Total pieces, outgoing (Minister's office excluded)	155,351

Postage:

Postage for the year, Records Branch	$3,288 58
" " " Colonization Branch	957 92
" " " Loan Commissioner	290 54

Files:

New files issued, general	8,650
" " " accounts chargeable	493
" " " accounts free	218

S. K. BURDIN,
Chief Clerk, Records Branch.

ALBERT GRIGG,
Deputy Minister

Appendix No. 14.

Statement showing the number of Locatees and of acres located; of purchasers and of acres sold; of lots resumed for non-performance of the settlement duties and of patents issued in Free Grant Townships during the year ending 31st October, 1917.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Baxter	Muskoka.....	J. B. Brown, Brace-	....	....	7	206	....	....	14	313
Brunel	"	" bridge	1	100	...	......	1	100	....	....
Cardwell	"	" "	1	100	...	......	1	100	....	....
Chaffey	"	" "	4	350	...	......	4	350	....	....
Draper	"	" "	1	195	...	......	1	195	....	....
Franklin . ..	"	" "	4	396	1	¾	3	289	4	256
Freeman	"	" "	....	....	...	......	....	....	....	....
Macaulay	"	" "	....	....	...	......	....	....	....	....
Medora	"	" "	....	....	...	......	....	....	....	....
Monck	"	" "	....	....	...	......	....	....	....	....
Morrison	"	" "	1	100	...	......	....	....	3	283
Muskoka	"	" "	....	....	...	......	....	....	1	101
McLean	"	" "	1	100	...	......	1	160	1	100
Oakley	"	" "	1	100	...	......	1	100	2	142
Ridout	"	" "	....	....	...	......	....	....	1	57
Ryde	"	" "	....	....	...	......	....	....	....	....
Sherborne....	"	" "	....	....	...	......	....	....	....	....
Sinclair......	"	" "	1	38	...	......	....	....	2	166¾
Stephenson...	"	" "	1	100	...	......	5	485	....	....
Stisted	"	" "	2	204	...	......	2	204	1	104
Watt	"	" "	1	11	...	......	1	11	1	32
Wood	"	" "	1	198	8	38	2	208	9	89
Blair	Parry Sound..	Miss I. M. Campbell,	....	....	4	15	....	....	5	18
Burpee	"	" Parry Sound	1	200	...	......	....	....	1	98
Carling	"	" "	6	660	...	......	3	261	5	213
Christie......	"	" "	1	98	...	......	1	202	4	674
Conger	"	" "	3	507	...	......	3	507	1	4¼
Cowper	"	" "	....	....	...	......	....	....	2	10
Foley	"	" "	2	175	...	......	....	....	....	....
Ferguson . ..	"	" "	2	200	...	......	3	300	....	....
Hagerman ...	"	" "	....	....	...	......	....	....	1	197
Harrison	"	" "	....	....	...	......	....	....	2	2
Henvey.......	"	" "	....	....	...	......	....	....	....	....
Humphrey ...	"	" "	2	283	1	43	1	143	2	390
McConkey....	"	" "	1	135	1	1	3	326	2	245
McDougall ...	"	" "	3	302	2	2	2	202	1	100
McKellar	"	" "	1	99	...	......	1	99	....	....
McKenzie	"	" "	....	....	...	......	1	200	1	100
Monteith	"	" "	6	661	3	244	4	401	1	229
Shawanaga ..	"	" "	....	....	...	......	....	....	1	17
Wilson	"	" "	1	200	...	......	1	200	....	....
Chapman	Parry Sound .	Dr. J. S. Freeborn,	5	598	...	......	4	399	1	200
Croft	"	" Magnetawan	3	343	...	......	2	243	3	489
Ferrie	"	" "	....	....	...	......	....	....	....	....
Gurd	"	" "	1	100	...	......	1	100	2	328
Lount........	"	" "	1	100	1	2	....	....	4	403
Machar	"	" "	4	613	...	......	3	215	2	276
Mills	"	" "	1	100	...	......	1	100	1	100
Pringle	"	" "	2	200	2	101	2	200	4	601

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Ryerson......	Parry Sound..	Dr. J. S. Freeborn, Magnetawan	....	....	...	......	....	....	1	100
Spence	"	" "	1	200	...	......	1	200	....	....
Strong	"	" "	....	....	...	......	....	....	....	....
Armour......	Parry Sound..	W. Jenkin, Emsdale..	....	....	...	......	....	....	2	104½
Bethune	"	" "	....	....	...	......	....	....	2	394
Joly	"	" "	3	391	...	......	3	391	2	190
McMurrich ...	"	" "	3	218	...	......	3	218	3	567
Perry	"	" "	....	....	...	......	....	....	1	200
Proudfoot....	"	" "	1	100	...	......	1	100	....	....
Hardy	Parry Sound..	H. J. Ellis, Powassan.	....	....	...	......	1	201	1	198
Himsworth ..	"	" "	5	611	...	......	6	611	4	522
Laurier......	"	" "	2	300	...	......	1	200	....	....
Nipissing....	"	" "	4	331	...	......	1	100	....	....
Patterson....	"	" "	....	....	...	......	....	....	2	257
Bonfield.... .	Nipissing	W. J. Parsons, North Bay	5	375	...	......	4	325	6	470
Boulter	"	" "	3	402	...	......	....	....	3	8,150
Chisholm	"	" "	3	315	1	6½	2	195	5	120
Ferris	"	" "	7	503	...	......	5	412	7	442
Anson	Haliburton ...	R. H. Baker, Minden..	....	....	...	......	....	....	....	....
Glamorgan ..	"	" "	1	100	...	......	1	100	....	....
Hindon	"	" "	....	....	...	......	....	....	....	....
Lutterworth..	"	" "	2	177	...	......	1	87	1	90
Minden	"	" "	3	305	...	......	....	....	3	191
Snowdon	"	" "	1	146	...	......	2	146	2	198
Stanhope.....	"	" "	....	....	...	......	....	....	....	....
Anstruther ...	Peterborough .	William Hales, Apsley	....	....	...	......	....	....	1	100
Burleigh, N.D.	"	" "	1	94	...	......	1	200	1	92
" S.D.	"	" "	1	175	...	......	....	....	....	....
Chandos	"	" "	1	100	...	......	2	200	....	....
Methuen	"	" "	1	125	...	......	....	....	....	....
Cardiff.......	Haliburton ...	A. N. Wilson, Kinmount	1	100	...	......	2	200	1	200
Cavendish....	Peterborough .	" "	1	155	1	49	2	327	....	....
Galway	"	" "	1	127	...	......	....	....	2	302
Monmouth ...	Haliburton ...	" "	5	404	1	12	7	750	3	494
Bangor	Hastings	W. J. Douglas, Greenview	2	168	...	......	....	....	....	....
Carlow.......	"	" "	4	551½	1	80	3	339½	1	193
Cashel	"	" "	1	100	...	......	2	200	2	200
Dungannon ..	"	" "	2	199	...	......	2	199	2	439
Faraday	"	" "	3	442	...	......	3	442	1	202½
Herschel	"	" "	7	692	1	63¾	2	195	5	548
Limerick.....	"	" "	1	100	...	......	....	....	....	....
Mayo	"	" "	1	129	2	43	....	....	5	1,312
Monteagle ...	"	" "	8	734	...	......	2	201	7	916
McClure	"	" "	2	288	...	......	1	105	1	98
Wicklow	"	" "	7	661	1	5	1	100	2	379
Wollaston....	"	" "	1	147½	...	......	2	147½	2	258½
Algona, S.....	Renfrew......	Adam Prince, Renfrew	....	....	...	......	....	....	....	....
Brougham ...	"	" "	5	654½	3	210	3	292	10	667
Brudenell ...	"	" "	2	136	...	......	1	46	....	....
Burns	"	" "	....	....	...	......	....	....	....	....

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Grattan	Renfrew	Adam Prince, Renfrew	3	281					3	251
Griffith	"	" "	1	93						
Hagarty	"	" "	2	152½	1	26			5	181
Jones	"	" "	2	298						
Lyell	"	" "	1	101			1	200	2	294
Lyndoch	"	" "	2	316	1	400	1	106	2	600
Matawatchan	"	" "	2	198					1	100
Radcliffe	"	" "								
Raglan	"	" "					6	657	2	535
Richards	"	" "	4	509	1	149	1	105	6	222
Sebastopol	"	" "	1	82						
Sherwood	"	" "	3	238			1	86		
Algona, N.	Renfrew	Finlay Watt, Pembroke	1	103						
Alice	"	" "	1	109					3	350
Buchanan	"	" "	1	168						
Fraser	"	" "	1	101						
Head	"	" "								
Maria	"	" "								
McKay	"	" "								
Petawawa	"	" "	1	102			1	102		
Rolph	"	" "	1	100			1	100		
Wilberforce	"	" "								
Wylie (pt.)	"	" "								
Calvin	Nipissing	Robt. Small, Mattawa	1	200			1	200	6	569
Cameron (pt.)	"	" "	17	2,029	2	98	5	476	1	236
Lauder	"	" "								
Mattawan	"	" "							2	334
Papineau	"	" "	2	300			3	300	4	501
Korah	Algoma	Edward Noble, Sault	1	80						
Parke	"	" Ste. Marie							1	80
Prince	"	" "	4	503	1	161	5	645		
Aberdeen	Algoma	Thos. Dodds, Thessalon	3	399¾			2	348½	1	127½
" add.	"	" "								
Galbraith	"	" "	2	361	2	22½			3	490
Lefroy	"	" "								
Plummer	"	" "								
" add.	"	" "								
St. Joseph Is'd	Algoma	W. E. Whybourne, Marksville	11	1,123½			9	776½	6	543
St. Joseph Ch'nl Is'd		" "							1	5
Baldwin	Algoma	Edward Arthurs,			1	40¼			1	40
Merritt	"	" Espanola	1	150			1	150	1	160½
Blake	Thunder Bay.	W. A. Burrows, Port	1	160			2	320	5	720
Conmee	"	" Arthur	4	446½	3	41	3	284	12	1,142
Crooks	"	" "	5	658			7	913	5	816
Dawson Road	"	" "	18	1,633½	5	165	18	1,412	4	377
Dorion	"	" "	4	638½			4	560	2	312½
Gillies	"	" "	1	200			1	160	1	56
Gorham	"	" "	4	552¼	2	135	2	270	8	1,210
Lybster	"	" "	3	336½	1	294	2	314½	3	492
Marks	"	" "	1	156½	2	159½	5	779	3	476
McGregor	"	" "	7	1,107	2	84	62	9,877½		
McIntyre	"	" "							3	462
O'Connor	"	" "			4	10½			7	1,051

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Oliver........	Thunder Bay.	W. A. Burrows, Port Arthur	2	321½	2	4	1	162	4	481
Paipoonge, N R	“	“	....	....	...	......	....	....	1	130
“ S R	“	“ “	....	....	...	......	....	....	1	100
Pardee......	“	“ “	1	160	1	80	1	160	....	....
Pearson......	“	“ “	9	1,403½	2	93¼	8	1,315½	1	160½
Scoble........	“	“ “	7	686½	1	161½	13	1,806	3	429
Stirling......	“	“ “	11	1,531	...	......	7	1,040½	....	....
Strange......	“	“ “	4	628½	...	......	4	627½	1	157
Ware	“	“ “	10	1,551½	1	53	4	635½	6	1,164½
Atwood	Rainy River..	William Cameron, Stratton	....	....	...	......	....	....	....	....
Blue	“	“	3	367	...	......	5	531	....	....
Curran.......	“	“ “	1	164	1	2	2	324	1	162
Dewart	“	“ “	3	480	1	2	3	486	....	....
Dilke	“	“ “	....	....	...	......	....	....	....	....
Morley	“	“ “	3	322	2	4	3	322	2	324
Morson	“	“ “	12	1,561¼	...	......	16	1,630	2	166
McCrosson ...	“	“ “	6	801¾	2	5½	7	918	7	1,108½
Nelles........	“	“ “	4	648	2	84	6	968	3	485
Pattullo... ..	“	“ “	7	800	3	12	6	719	3	409
Pratt	“	“ “	1	162	1	44¾	1	159½	4	530
Rosebery	“	“ “	....	....	...	......	....	....	....	....
Shenston.....	“	“ “	....	....	...	......	....	....	....	....
Sifton	“	“ “	11	1,246½	...	......	6	1,008½	4	589
Spohn	“	“ “	7	1,074¾	1	29	9	1,310½	4	544
Sutherland ...	“	“ “	5	797½	1	45½	6	958	1	203½
Tait	“	“ “	8	949	4	242½	3	488	1	160
Tovell	“	“ “	5	859	1	79¼	7	970	2	325
Worthington..	“	“ “	....	....	...	......	1	81	5	350
Aylsworth ...	Rainy River..	Alex. McFayden, Emo.	....	....	...	......	....	....	2	320
Barwick	“	“ “	....	....	...	......	....	....	....	....
Burriss	“	“ “	1	183	1	2	....	....	6	678½
Carpenter	“	“ “	....	....	1	½	....	....	3	398
Crozier.......	“	“ “	....	....	1	37	....	....	5	658
Dance........	“	“ “	8	1,270½	2	38½	9	1,429½	6	[illegible]
Devlin	“	“ “	....	....	1	40½	....	....	....	....
Dobie	“	“ “	1	160½	...	......	1	160½	....	....
Fleming	“	“ “	1	160½	...	......	1	160½	....	....
Kingsford	“	“ “	6	960	1	1	8	1,277½	2	428
Lash..........	“	“ “	1	164	...	......	1	164	....	....
Mather	“	“ “	4	665	...	......	3	500	....	....
Miscampbell .	“	“ “	3	479½	2	159½	6	984½	2	318½
Potts	“	“ “	5	815½	1	40	7	1,015½	6	898
Richardson...	“	“ “	5	849	1	80	7	1,166	1	161
Roddick......	“	“ “	....	....	...	......	....	....	....	....
Woodyatt	“	“ “	....	....	...	......	....	....	....	....
Aubrey	Kenora	J. E. Gibson, Dryden..	5	558	2	36	5	470½	....	....
Britton	“	“ “	....	....	...	......	1	160	....	....
Eton..........	“	“ “	6	927	1	50	6	886	....	....
Langton	“	“ “	3	396½	1	78½	3	476½	....	....
Melgund	“	“ “	4	571	1	3	8	830½	....	....
Mutrie.......	“	“ “	6	936½	4	165	7	1,098	1	6
Redvers	“	“ “	5	589½	5	254	3	439½	4	394
Rowell	“	“ “	2	222½	...	......	2	222½	....	....
Rugby	“	“ “	....	....	...	......	....	....	....	....
Sanford......	“	“ “	3	456	...	......	3	456	1	159½
Southworth ..	“	“ “	1	136	2	149	....	....	3	3
Temple.......	“	“ “	5	703¼	2	108	5	681	....	....

Appendix No. 14.—Concluded.

Township.	District or County.	Agent.	No. of persons located.	No of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Van Horne ...	Kenora	J. E. Gibson, Dryden..	2	179	1	40	1	110	3	240
Wabigoon	"	" "	3	497	2	73½	4	644½	2	214
Wainwright ..	"	" "	3	474½	....	....	1	160	....	....
Zealand	"	" "	13	1,935½	1	28	9	1.352	3	624
Melick	Kenora	W. L. Spry, Kenora....	9	1,135½	2	61	6	933	2	319
Pellatt	"	" "	4	381½	....	....	3	356½	1	40
Balfour	Sudbury......	J. K. MacLennan, Sudbury	....	....	....	....	....	....	1	154½
Blezard	"	" "	1	61¼	2	394½	1	157	10	396
Broder.......	"	" "	1	138	....	....	1	138	2	319
Capreol	"	" "	3	353	1	99	1	149	2	99
Chapleau.....	"	" "	....	....	....	....	....	....	....	....
Dill..........	"	" "	3	453½	....	....	....	....	1	127
Garson.......	"	" "	5	657¾	4	221	5	533	8	460
Hanmer......	"	" "	3	266¼	1	45½	1	101¼	....	....
Lumsden.....	"	" "	9	1,374¼	1	1½	2	320	....	....
Morgan.......	"	" "	2	317	....	....	2	317	....	....
Neelon........	"	" "	3	287	....	....	1	165	2	200
Rayside......	"	" "	2	263½	1	61½	....	....	2	190
Appelby	Sudbury	John Brown, Markstay	6	902½	3	7	....	....	3	400
Casimir	"	" "	2	304	....	....	....	....	....	....
Dunnet.......	"	" "	1	159	1	1½	....	....	3	486
Hagar	"	" "	12	1,915½	1	80¼	6	958½	2	240
Jennings	"	" "	....	....	....	....	....	....	....	....
Kirkpatrick ..	Nipissing ...	" "	3	416½	....	....	....	....	3	417
Ratter	Sudbury	" "	1	160	....	....	....	....	2	320
Caldwell	Nipissing	J. A. Philion, Sturgeon Falls	2	321	....	....	....	....	3	219
Cosby........	Sudbury	" "	1	160½	....	....	....	....	....	....
Grant...... .	Nipissing . .	" "	7	979½	....	....	4	423	2	290
Macpherson ..	"	" "	11	1,623	....	....	1	156	4	580½
Martland.....	Sudbury	" "	6	786½	1	1½	1	159½	2	322
Springer	Nipissing	" "	5	667	....	....	2	320	5	606
Abinger......	Lennox and Addington	Charles Both, Denbigh	1	200	....	....	....	....	2	400
Canonto, S....	Frontenac....	" "	....	....	....	....	....	....	....	....
" N...	"	" "	....	....	....	....	....	....	....	....
Clarendon....	"	" "	1	151	1	1½	....	....	3	406
Denbigh.. .	Lennox and Addington	" "	2	150	....	....	2	150	....	....
Miller (pt.) ...	Frontenac....	" "	....	....	....	....	....	....	....	....
Palmerston	"	" "	....	....	....	....	....	....	....	....
McClintock ...	Haliburton....	Unattached	1	100	....	....	....	....	....	....
Airy.........	Nipissing.....	"	2	399	....	....	....	....	....	....
Finlayson....	"	"	....	....	....	....	....	....	....	....
Murchison ...	"	"	....	....	....	....	....	....	....	....
Sabine	"	"	....	....	....	....	....	....	1	226
			610	78.192¼	147	6.209¾	529	69.474¼	449	59.300

No. of lots assigned	No. of acres assigned
217	27,441

SELBY DRAPER, Free Grants Clerk.
W. C. CAIN, Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 15.

Statement showing the number of purchasers and of acres sold; of lots resumed for non-performance of the settlement duties; and of patents issued in Townships other than Free Grant during the year ending 31st October, 1917.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Armstrong ...	Temiskaming.	J. W. Bolger, New Liskeard	159	1	....	....	7	1,120
Auld	"	" "	557	4	....	....	3	113
Beauchamp...	"	" "	793½	5	1	160	4	637
Brethour	"	" "	536	4	2	309½	4	360
Bryce	"	" "	479½	3	....	....	1	40
Bucke	"	" "	120	1	2	322	1	120
Cane	"	" "	887	6	6	964	5	199
Casey	"	" "	743½	5	....	....	17	1,375
Dymond	"	" "	313	2	....	....	3	634½
Firstbrook	"	" "	275	2	2	319	1	2
Harley	"	" "	475	3	....	....	3	400
Harris	"	" "	480	3	....	....	3	243½
Henwood	"	" "	350	3	1	161½	3	400
Hilliard	"	" "	552¾	4	2	316½	3	400
Hudson	"	" "	281	3	....	....	5	545
Kerns	"	" "	320	2	....	....	9	1,441
Lundy........	"	" "	481½	3	1	162½	....	....
Tudhope......	"	" "	455¾	3	....	....	4	271½
Smyth	Temiskaming.	J.A.Browning, Elk Lake	249	2	1	90½	....	....
Lorrain	Temiskaming.	Neil J. McAulay, Haileybury	21	1	....	....	5	760
Beatty	Temiskaming.	F. E. Ginn, Matheson ..	871½	6	2	234½	7	396
Benoit........	"	" "	2,637¾	17	3	478½	1	142½
Bond	"	" "	475	3	....	....	....	....
Bowman......	"	" "	639½	4	....	....	4	639½
Calvert.......	"	" "	158	1	5	792	....	....
Carr	"	" "	1,319	10	....	....	4	366½
Clergue.......	"	" "	321	2	4	641	1	159
Currie........	"	" "	155½	1	1	144	1	156½
Dundonald	"	" "	1,433½	10	4	543	1	5
Evelyn	"	" "	5,270	33	....	....	....	....
German	"	" "	2,184	14	....	....	....	....
Hislop........	"	" "	2,366	15	2	308½	4	641
Matheson.....	"	" "	3,150	20	1	477	2	200
Mountjoy	"	" "	4,636½	30	5	791½	1	148½
McCart.......	"	" "	1,725½	11	1	160	....	....
Playfair......	"	" "	2,278½	14	....	....	2	321
Stock	"	" "	2,858	18	3	476½	....	....
Taylor	"	" "	633½	4	1	162½	2	310½
Walker.......	"	" "	455½	3	3	455	3	477
Blount	Temiskaming.	S. J. Dempsay, Cochrane	1,125	9	....	....	1	1
Brower.......	"	" "	320	2	....	....	2	322
Calder........	"	" "	1,661	11	84	12,564	1	119
Clute	"	" "	2,800	18	10	1,427	2	295
Colquhoun	"	" "	151	1	....	....	....	....
Fauquier	"	" "	7,516	51	....	....	....	....
Fournier	"	" "	610½	4	58	8,801½	....	....
Fox	"	" "	2,872	18	4	631	....	....
Glackmeyer ..	"	" "	940	6	3	489	7	1,038
Kennedy	"	" "	1,507	10	....	....	....	....
Lamarche	"	" "	619	4	....	....	1	163½
Leitch........	"	" "	301	2	....	....	....	....
Newmarket...	"	" "	481½	3	2	322	....	....
Pyne	"	" "	477½	3	....	....	....	....
Shackleton ...	"	" "	9,502	66	31	4,711	....	....

Appendix No. 15.—Continued.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Catharine	Temiskaming	Jos. Woollings, Englehart	322	2	1	163	2	153
Chamberlain	"	" "	554½	4			4	623
Dack	"	" "	647½	4			4	584½
Eby	"	" "					9	360
Ingram	"	" "	720½	5	4	640	2	161½
Marter	"	" "	160	1			6	938
Marquis	"	" "	320	2	1	160		
Otto	"	" "	145½	1			8	298½
Pacaud	"	" "	1,880	12	4	632½	5	434½
Pense	"	" "	482	3	1	160		
Robillard	"	" "	402	3			2	320
Savard	"	" "	632½	4	3	479	6	953½
Sharpe	"	" "	403½	3			4	434
Truax	"	" "	79½	1	1	159½		
Evanturel	"	" "					7	941½
Casgrain	Algoma	T. V. Anderson, Hearst.	1,544	10	2	299		
Eilber	"	" "	491	3				
Hanlan	"	" "	1,812	12	2	302		
Kendall	"	" "	600	4	1	150	2	200
Lowther	"	" "	743	5				
Forbes	Thunder Bay	W. A. Burrows, Port Arthur	3,161½	24				
Lyon	"	" "	504½	3			1	148
Nepigon	"	" "	4,204½	27	1	166	107	16,414
Aweres	Algoma	E. Noble, Sault Ste. Marie	678	5	3	474	2	5½
Tarentorus	"	" "	838	6	1	160		
Vankoughnet	"	" "					1	184
Watten	Rainy River	C. J. Hollands, Fort Frances	150	1				
Day	Algoma	Thos. Dodds, Thessalon.	8	1	1	132		
Gladstone	"	" "	143	1				
Haughton	"	" "					1	155½
Kirkwood	"	" "	141	1				
Parkinson	"	" "					3	394
Patton	"	" "					1	160
Rose	"	" "					4	627
Thompson	"	" "	159	1			2	310¾
Hallam	Algoma	R. W. Teasdale, Massey					2	200
Harrow	"	" "					1	160
May	"	" "	378	2			2	378
Salter	"	" "	310	3				
Victoria	"	" "	296	2				
Dowling	Sudbury	J. K. MacLennan, Sudbury	201	2			2	244¾
Scollard	Nipissing	J. A. Philion, Sturgeon Falls	473½	3				
Mason	"	" "	110	1			1	7½
Hugel	Nipissing	John Brown, Markstay.	160½	1				
Loudon	"	" "	160	1	1	130½		
Widdifield	Nipissing	W.J. Parsons, North Bay	829	5	4	640½		
Admaston	Renfrew	Unattached					6	700
Bagot	"	"	335	4			5	495
Bromley	"	"					1	380
Alfred	Prescott	Unattached	343	1			1	343

Appendix No. 15.—Continued.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Adolphustown	Lennox	Unattached	9	1			1	9
Sheffield	"	"					2	300
Artemesia	Grey	Unattached					3	265
Bentinck	"	"					2	151
Glenelg	"	"					2	149
Proton	"	"					4	306
Sullivan	"	"					1	50
Arran	Bruce	Unattached					1	98½
Brant	"	"					1	50
Bruce	"	"					5	450
Greenock	"	"					1	96
Huron	"	"					1	50½
Kincardine	"	"					1	100
Saugeen	"	"					1	129
Barrie	Frontenac	Unattached					2	200
Bedford	"	"					1	1½
Kennebec	"	"	216½	1			4	226½
Bathurst	Lanark	Unattached					1	165
Beckwith	"	"	3	1			1	3
Elmsley	"	"					1	49
Lanark	"	"					1	100
Plantagenet	"	"					1	50
S. Sherbrooke	"	"					1	50
N. Sherbrooke	"	"					1	100
Sandwich, E.	Essex	Unattached	8¼	1				
Sandwich, W.	"	"	50¾	4			2	1
Windsor (City)	Essex	Unattached					3	16
Seymour	N'thumberl'd.	Unattached					1	21
Dennison	Sudbury	Unattached	193	2				
Drury	"	"					2	91
Dryden	"	"	772	5				
Falconbridge	"	"	470	3			22	981
Graham	"	"	262	2			2	100
Levack	"	"	200	1			3	241
Lorne	"	"	531	4			1	138
Louise	"	"	597	6			6	638½
MacLennan	"	"					5	183
Snider	"	"					2	100
Waters	"	"	170½	2			1	160
Badgerow	Nipissing	Unattached	478	3			4	643
Bastedo	"	"	320	2			2	320
Field	"	"					1	5
Gibbons	"	"	480	2			1	320
Malachi	Kenora	Unattached	60	15			21	35½
Redditt	"	"	27	4			4	27
Carden	Victoria	Unattached	100	1			1	100
Dalton	"	"					2	154
Laxton	"	"	152	2			4	352
Somerville	"	"	98	1				
Edwardsburgh	Grenville	Unattached					1	50

Appendix No. 15.—Concluded.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Harvey	Peterborough	Unattached	202	1			1	210
Haughton	Norfolk	Unattached					1	50
Hungerford	Hastings	Unattached					1	50
Tudor	"	"					2	199
Humberstone	Welland	Unattached					1	$89\frac{3}{4}$
Matchedash	Simcoe	Unattached	88	3			2	155
Oro	"	"					1	50
Peel	Wellington	Unattached					2	150
Rama	Ontario	Unattached					1	100
Colden	Algoma	Unattached	92	1			3	$373\frac{1}{2}$
Gould	"	"	146	1				
Townsite—								
Hearst	"	T. V. Anderson	$4\frac{2}{5}$	10				
Hilton	"	W. E. Whybourne	$8\frac{1}{2}$	2			1	8
Townsite—								
Armstrong	Temiskaming	Unattached	4	2				
Grant	Kenora	"	$3\frac{1}{5}$	16			2	$\frac{1}{2}$
MacFarlane	"	"	3	2			3	$2\frac{3}{4}$
Sioux Lookout	"	"					6	3
Winnipeg River Crossing	"	"	1	1			5	$2\frac{3}{4}$
WATER LOTS.								
Township of Humberstone	Welland	Unattached	90	1				
Saltfleet	Wentworth	"					1	$5\frac{3}{4}$
City of Windsor	Essex	"					1	$1\frac{3}{4}$
ISLANDS.								
Mason— Part Island C	Nipissing	J. A. Philion	$7\frac{1}{2}$	1				
S. Elmsley— Part Island 2	Lanark	Unattached	$\frac{93}{100}$	1				
" 3	"	"	$4\frac{52}{100}$	1				
" 4	"	"	$1\frac{83}{100}$	1				
" 5	"	"	$1\frac{26}{100}$	1				
Pt. Island in Otter Lake	"	"	$4\frac{13}{100}$	1				
N. Elmsley— Pt. Island in Sand Lake	"	"	$7\frac{6}{100}$	1				
Bedford— Island 34	Frontenac	"	$\frac{4}{5}$	1				
Escott (rear of) Flat Island	Leeds	"	$2\frac{4}{5}$	1				
Malachi— 6 Islands	Kenora	"	$14\frac{1}{2}$	6			6	$14\frac{1}{2}$
		Total	$104,385\frac{48}{100}$	776	276	42,263	501	$51,745\frac{1}{4}$

W. R. LEDGER, Sales Clerk.
W. C. CAIN, Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 16.

Statement of Crown Surveys completed and closed during the twelve months ending October 31st, 1917.

No.	Date of Instructions.	Name of Surveyor.	Description of Survey.	Amount Paid.	Area in Acres.
				$ c.	
1	Apr. 15, 1915	J. S. Dobie	Survey of islands north and west of Manitoulin Island, Districts of Algoma and Manitoulin	5,388 24	
2	Apr. 20, 1915	Lang & Ross ...	Survey of Islands on the North Shore of Lake Huron and Georgian Bay, Districts of Manitoulin, Sudbury and Parry Sound	4,500 08	
3	Apr. 16, 1915	T. J. Patten ...	Survey of islands in Lake Huron, east and north-east of Manitoulin Island, District of Manitoulin..	6,036 98	
4	May 26, 1916	Phillips & Benner	Survey of Nepigon Forest Reserve in District of Thunder Bay	3,300 00	
5	June 13, 1916	David Beatty ..	Survey of the Township of Foleyet, in the District of Sudbury	1,637 34	51,470
6	June 30, 1916	R. S. Code	Survey of the Township of Muskego, in the District of Sudbury	819 82	51,589
7	Sept. 5, 1916	J. W. Fitzgerald	Survey of Township outlines in the District of Algoma	1,308 55	
8	Sept. 21, 1916	McAuslan & Anderson	Survey of Town Plot of Bear Island in the District of Nipissing	533 41	
9	July 31, 1916	R. S. Code	Survey of part of the Township of Keith, in the District of Sudbury	3,098 70	25,989
10	Oct. 18, 1916	McAuslan & Anderson	Survey of the line between Townships of Gooderham and Kenny, District of Nipissing	360 21	
11	Oct. 23, 1916	Sutcliffe & Neelands	Survey of lines in the Townships of Ogden, Bristol and Thornloe, District of Timiskaming	657 92	
12	Nov. 25, 1916	McAuslan & Anderson	Survey of certain lots in the Township of Notman, in the District of Nipissing	158 76	
13	Feb. 19, 1916	McAuslan & Anderson	Survey of Mesomikenda and Minisinakawa Lakes, in the District of Sudbury	610 31	
14	May 31, 1917	J. R. Gill	Survey of line in the Township of Sweeny, in the District of Sudbury	389 44	
15	Jan. 27, 1917	Alex. Baird	Assisting Jas. Hutcheon, Inspector of Surveys in outlining water lots of Fishing Point, Pelee Island	65 00	
				28,864 76	129,048

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 17.

Statement of Surveys in progress during the twelve months ending October 31st, 1917.

No.	Date of Instructions.	Name of Surveyor.	Description of Surveys.	Amount Paid. $ c.
1	Apr. 20, 1915	Lang & Ross ...	Survey of islands on the North Shore of Lake Huron and Georgian Bay, Districts of Manitoulin, Sudbury and Parry Sound.	4,000 00
2	July 13, 1917	D. J. Gillon	Survey of the Namakan River, District of Rainy River	1,000 00
3	July 24, 1917	J. L. Morris	Survey of the Township of Kapuskasing, District of Algoma	3,850 00
4	Aug. 30, 1917	David Beatty ..	Re-survey of the Township of O'Brien, District of Algoma	3,000 00
5	Sept. 7, 1917	A. L. Russell ...	Survey of the shores of Lower Shebandowan Lake, District of Thunder Bay	500 00
6	Oct. 19, 1917	H. M. Anderson.	Re-survey of the Township of Owens, District of Timiskaming	1,000 00
7	Oct. 24, 1917	J. S. Dobie	Survey of the Township of Idington, District of Algoma	1,000 00
				14,350 00

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 18.

Statement of Municipal Surveys for which instructions issued during the twelve months ending October 31st, 1917.

No.	Name of Surveyor.	No.	Date of Instructions.	Description of Survey.
1	G. A. McCubbin	708	Oct. 31st, 1916.	To survey the road allowance between lots 24 and 25, across concession 1, west of the Communication Road, Township of Harwich, in the County of Kent, and to plant stone or other durable monuments to mark the said road allowance.
2	C. A. Jones .	709	Nov. 2nd, 1916.	To survey the boundary line between the Townships of Greenock and Culross, in the County of Bruce, and to plant stone or other durable monuments to mark the said boundary.
3	Jas. J. McKay	710	Dec. 5th. 1916.	To survey the limits of that portion of the original allowance for road between the 2nd and 3rd concessions of the Township of Barton, in the County of Wentworth (now called Main Street) lying in the City of Hamilton, between the original allowance for road between lots Nos. 18 and 19 of the said Township (Dundurn St.), on the east, and the division line between the Townships of Barton and Ancaster on the west, to be defined and marked by durable monuments placed at the intersections of the said road allowance (Main Street) with Dundurn Street, the division line between lots Nos. 19 and 20, the Hamilton and Dundas Stone Road, Macklin Street and Paradise Road.
4	Oliver Smith.	711	May 30th, 1917	To survey the concession road allowance between concessions 4 and 5 in the Township of Verulam across lot No. 5, and that stone or other durable monuments be placed at the front angles of lot No. 5 in the 5th concession.
5	Oliver Smith.	712	July 24th, 1917	To survey the concession line between concessions 9 and 19, opposite lot 17, Township of Cartwright.
6	R. W. DeMorest	713	Sept. 4th, 1917.	To survey the concession line between concessions 1 and 2 across lots 1 to 4 inclusive, in the Township of Balfour, and that stone or other durable monuments be placed at the front angles of the lots fronting on said part of concession.
7	W. S. Gibson..	714	Sept. 20th, 1917	To survey the original road allowance between lots 20 and 21 in the 2nd concession, of the Township of York, west of Yonge Street, and to mark the same by monuments of stone or other durable material.
8	E. D. Bolton..	715	Sept. 21st, 1917	To survey the road allowance between lots 10 and 11, across concessions 9 and 10, in the Township of Egremont, in the County of Grey, and to plant stone or other durable monuments to mark the boundaries of said road allowance.

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 19.

Statement of Municipal Surveys confirmed during the twelve months ending October 31st, 1917.

No.	Name of Surveyor	No.	Date of Instructions.	Description of Surveys.	Date when confirmed under R.S.O. 1914, Chap. 166, Secs. 10-15 inclusive.
1	W. G. McGeorge	697	Mar. 24th, 1915	To survey the concession line between concessions 2 and 3, in the Township of Harwich, from lot No. 3 to the waters of the Rond Eau and to plant stone or iron monuments on each side thereof.	Apr. 4th, 1917.
2	George A. McCubbin	700	June 22nd, 1915	To survey the line in the Township of Zone from between the 3rd and 4th concessions across concessions 4, 5 and 6 to the Longwoods Road and to mark the said line by permanent monuments.	Dec. 15th, 1916
3	J. J. MacKay ..	704	Oct. 22nd, 1915	To survey the road allowance between the broken front and the first concession of the Township of North Grimsby, from the easterly limit of the said Township of North Grimsby to the allowance for road between lots Nos. 6 and 7 in the first and broken front concessions, and that durable monuments be planted defining the limits of the 66-foot reservation for a highway between the said broken front and the first concession of the Township of North Grimsby from the easterly limit of the said Township to the allowance for road between lots Nos. 6 and 7, in the first and broken front concessions.	Jan. 24th, 1917
4	George A. McCubbin	708	Oct. 31st, 1916	To survey the road allowance between lots 24 and 25, across concession 1, west of the Communication Road, Township of Harwich, in the County of Kent, and to plant stone or other durable monuments to mark the said road allowance.	Jan. 18th, 1917
5	Speight & Van Nostrand...........	7477	Apr. 21st, 1915	To survey the easterly part of the Toronto and Hamilton Highway.	July 12th, 1917

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 20.

SURVEY OF THE EAST LIMIT AND THE EAST 22 MILES OF THE SOUTH LIMIT OF NEPIGON FOREST RESERVE, DISTRICT OF THUNDER BAY.

PORT ARTHUR, December 21st, 1916.

SIR,—We beg to report that according to instructions dated May 26th, 1916, we have surveyed the east boundary and that part of the south boundary east of the township of Ledger, of the Nepigon Forest Reserve.

From the south-east angle of the township of Ledger, where the iron tube planted by O.L.S. T. B. Speight was found, the south boundary was run east astronomically, with reference to a meridian through its central point, a distance of twenty-two miles; from this point a meridian was run north ninety-eight miles to the north-east angle of the Reserve. Frequent observations were taken to ensure the correct bearing of the lines.

Wooden posts were planted at every mile on the lines and iron posts 1¼ in. in diameter at intervals of six miles, starting from west to east on the south boundary and from south to north on the east boundary. Posts were numbered from one to twenty-one on the south boundary and from one to ninety-seven on the east boundary. At the end of the 22nd mile on the south boundary and the 98th mile on the east boundary iron posts 1⅞ in. in diameter, marked Nepigon Forest Reserve, were planted.

The ends of the 2nd, 4th, 38th, 40th, 46th and 79th miles on the east boundary coming in bodies of water, the posts were planted on the nearest shore and marked accordingly.

MINING CLAIMS.

No mining claim surveys were crossed. Where, from the tracing furnished us, it appeared that we should be in the neighborhood of M C 50 and 57, and M C 56 and 58, we were careful to search for these, but no evidence was found of any survey. Stakes were found with no marks on them as shown on pages 61 and 62 of field notes.

SOIL.

With the exception of the first mile and a half on the south boundary which is clay, the soil passed over was sand and muskeg; on the remainder of the south boundary there is no soil worth mentioning, it being almost entirely rock and small muskegs. Going north on the east boundary after the first five or six miles the rock gradually becomes less prominent and the country in general varies from rolling to flat with an occasional rocky hill. The level country is usually in the form of muskeg or swamp, the only pronounced exception to this being immediately south of the Canadian Northern Railway where there is an area of level land about three-quarters of a mile across. From about six miles north of the Canadian Northern Railway to the end of the line the country is roughly about one-half muskeg or swamp, the remainder being low ridges of rock or both.

Rock Formation.

The rock of the south boundary is all granite with an occasional small belt of diabase running through it, this formation appears to continue on the east boundary to the south side of the lake on the 36th mile; from the north side of this lake the Keewatin formation predominates up to the 57th mile where the granite comes in again for about four miles, then the formation is Keewatin with small belts of diabase up to the 65th mile where granite occurs again and continues up to about the end of the 68th mile. From here to the end of the line the rock is principally Keewatin with belts of diabase. From the 83rd mile northward there is considerable local attraction (the maximum noted was 39 degrees west on the 84th mile) indicating the presence of iron-bearing rocks.

Timber.

The principal timber throughout almost the entire line is spruce. On the south boundary for the first six miles the growth is thick and small and there is no timber of any value. This occurs again on the 9th and 11th miles; also on the east boundary, on the 89th to the 93rd miles the timber is small and thick and consists principally of birch, poplar and jack pine. With these exceptions, however, the country is well wooded with spruce, balsam, birch and some jack pine from 3 to 18 in. on the south boundary and for about six miles north on the east boundary where the poplar is present more frequently and the timber is somewhat larger from this point north, the largest timber being about 24 inches in diameter, but averaging from 5 to 8 inches. On the northerly half of the east boundary the muskegs and swamps occur more frequently, but the timber on the high ground remains the same with a few exceptions. In the swamps some cedar is met with but it is usually of a short, scrubby growth, the principal timber in the swamps being spruce, usually small, and dead tamarac. Some jack pine of sufficient size to be of value occurs on the 34th and 35th miles, the 39th, 40th and 41st miles, the 51st and 52nd miles, and some slightly smaller in size on the 96th mile.

The recently burned areas are small and occur on the 35th and 36th miles, the 56th mile, the 77th to the 79th mile, while a fire of comparatively recent date has been over the country from the north side of Lily lake to the 94th mile.

Game, Etc.

Moose, deer and caribou are plentiful along the south boundary and the southerly part of the east boundary, but farther north, while present, they do not appear to be as numerous.

On the south boundary and north on the east boundary as far as about the 30th mile, beavers are very numerous, but from this point up to the 49th mile none of their work was seen; from this point they are absent again up to that part of the east boundary north of the 81st mile where they appear again.

The only kinds of fish seen or caught were pike, pickerel and whitefish. The waters of the lakes up to the lake at the 37th mile, while having no disagreeable taste, are dark in colour, but this lake and most of those north of it are clear, but notwithstanding this no trout were seen or caught.

During the survey frequent reference was made to the maps issued by the Dominion Geological Department, and the Department of the Interior. These were found to be very reliable except in the case of the topographical sheet for district south and east of the south boundary, but for this portion of the country all maps were found to be incorrect.

We have the honour to be, Sir,

Your obedient servants,

(Signed) PHILLIPS & BENNER,

Ontario Land Surveyors.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 21.

SURVEY OF THE TOWNSHIP OF FOLEYET, IN THE DISTRICT OF SUDBURY.

PARRY SOUND, December 29th, 1916.

SIR,—I have the honour to report that under your instructions dated the 13th day of June, 1916, I have subdivided the township of Foleyet into farm lots. I commenced the survey at the south-east angle of the township by chaining the south boundary westward and planting posts making the lots 25.25 wide, exclusive of side-road allowance. At the side-road between lots 6 and 7 I observed Polaris at Eastern Elongation (Azimuth 1 degree 43 minutes) and ran line due north in centre of road allowance (1 chain wide), and after chaining the east boundary of the township one mile and a half north from said south-east corner, I turned angle from a long range of pickets and ran due west to intersection of said side-road line and checked angle which I found to be correct and continued the survey throughout the township observing Polaris frequently for meridian and correcting any small errors in direction of lines. I made survey of all lakes that my lines intersected as well as those that I found when travelling across country.

I made a careful traverse of Pishkanogama river, which is the outlet of Pishkanogama lake and which enters the township from the south on lot 19, and runs northerly and easterly through the township to lot 5, in concession 11, where it turns westerly to lot 9, thence northerly crossing the north boundary on lot 10. On lots 8, 9, 10 and 11 the river expands to the north and south, the largest expansion in concessions 8, 9 and 10 being known as Sand lake. There are no falls on the river but it breaks into rapids in concession 2 which continue to lot 13 in concession 3, and again into rapids in concession 8, which continue down to the bend westward on lot 6, concession 11.

There is a fall of about seventy feet between Pishkanogama lake and the river at the foot of the rapids on lot 13, concession 3, but I do not think that there is any feasible place on the river for creating a water power, and the same conditions

apply to the rapids further north where there is a difference in level of about fifty feet between the head and foot of rapids; there is no part of either rapids that cannot be run with a canoe.

The south four concessions of the township, east of side-road 24 and 25 is sandy and rolling and in places with hills from 20 to 50 ft. high. Commencing on lots 24 and 25 the country is broken with rocky ridges in some places more than 100 ft. high and wholly unfit for agricultural purposes. This rocky country extends northward through the township. North of the line between concessions 4 and 5 there is a gradual change of soil from sand to clay, and there is some fairly good agricultural land extending from the east boundary westward to the rocky belt in the western part of the township. I do not think that there is more than forty per cent. of the township fit for agricultural purposes.

The Canadian Northern Railway enters the township from the east in concession 3 and crosses the north boundary in concession 12 on lot 13.

The timber in the township is principally spruce and jack pine, a considerable part of the latter being large enough for railway ties and some suitable for lumber. There is a small area of red and white pine in concessions 1 and 2, extending from lot 10 to lot 15, and again there is considerable pine in concessions 6, 7, 8, 9 and 10, between side-road 6 and 7 and side-road 12 and 13. The rock formation is granite.

There are white fish, lake trout, speckled trout, pickerel and pike in Pishkanogama lake, and I expect the same in the expansions of the river farther north although white fish and pickerel were the only kinds that we caught when camped there. The only game I saw was moose.

The village of Foleyet is on lots 5 and 6, in concession 6, and has a population composed chiefly of railway employees. It is a divisional point on the Canadian Northern Railway. There are about twenty houses besides the round house and machine shop.

I have the honour to be, Sir,

Your obedient servant,

(Signed) David Beatty,

Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 22.

Survey of the Township of Muskego, in the District of Sudbury.

Toronto, Ont., May 24th, 1917.

Sir,—I have the honour to submit the following report of the survey of the township of Muskego, in the district of Sudbury, under instructions received from your Department dated June 30th, 1916.

Commencing at the 18th mile post planted by O.L.S. T. B. Speight at the south-east angle of the township of Muskego, I proceeded with the survey by cutting out and re-chaining the line between the township of Muskego and Keith. This line being run in the year 1909 was greatly obstructed by fallen timber, with a considerable growth of underbrush. Having chained my base along this line and determined the astronomical bearing of same, I proceeded with the survey in accordance with instructions, running north astronomically along the line between lots 6 and 7 for several miles, thence north astronomically along the line between lots 12 and 13, laying off the concession lines running east and west from the measurements set forth in the instructions finishing the south-east section of the township first, thence the north-east section, thence the north-west section, thence the south-west section.

Owing to the continued unfavourable weather which set in about the middle of October I was obliged to withdraw from the work without completing the traverse of the lakes and rivers, as it was impossible to travel the waters by canoe or on ice. Returning in the month of February I proceeded with the traverse work, and finally, after the third attempt, completed the same in the month of April.

The survey throughout was made with the transit. Particular attention was given to the proper cutting of the line, also to the blazing, posting and chaining of same. Durable posts were made, carved in the regular way with a scribe, and securely planted. Iron posts were planted according to instructions, with one exception, the iron post instructed to be planted on the west boundary of Muskego, at the intersection of concession line 6 and 7, was inadvertently placed at the south-west angle of lot 24, concession 7.

Physical Features.

The general nature of the township is rolling. Very few large hills exist. The swamps are very numerous, being chiefly spruce and cedar swamps with dry tamarac. These swamps are underlaid with boulders, which in various places protrude to the surface.

Drainage.

The township is drained by the Scorch river, formerly called the Sturgeon river, and by the Muskego river—the Scorch river and lake draining the greater part of the township. Slate Rock lake, Singed-tree lake, and Winter Spawning lake, all drain to the Scorch river. This river, when improvements are made at the narrows in lot 16, concession 4, by removing of boulders and widening the channel, will be of great benefit in lumbering operations for the conveyance of lumber to the railway.

Timber.

The township is heavily timbered with spruce, balsam, birch, poplar and jack pine, with scattering white pine. Cedar is found along the banks of the rivers and lakes and in the swamps. The timber is most suitable for pulpwood and railway ties.

The windfall of timber is general throughout the township, which, in my opinion, is caused from the light overburden of soil.

Soil.

The soil is principally of a sandy nature with little clay or loam; boulders of rock are predominant throughout the soil, and for which reason I would consider about fifty per cent. of the township suitable for agricultural purposes.

Minerals.

The rock formation chiefly consists of keewatin and granite, the keewatin rock being composed of greenstone and schist. In this is found quartz veins, but no mineral of economic value was found.

Game and Fish.

Game is most plentiful, consisting of moose, bear, wolves, fox, mink, beaver and martin.

Fish is also plentiful, chiefly pike and pickerel.

The magnetic variation is constant, being six degrees and thirty minutes west of astronomical north.

I submit with this report, general plan, timber plan, field notes and traverse plans.

All of which is respectfully submitted.

I have the honour to be, Sir,

Your obedient servant,

(Signed) R. S. Code,

Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 23.

Survey of Outlines of Townships, District of Algoma.

Peterborough, Ont., March 15th, 1917.

Sir,—I have the honour to submit the following report on the survey of certain township outlines in the district of Algoma, made by me under instructions from

your Department, dated September 5th, 1916. I also beg to submit herewith the plans, field notes and account in connection with this survey, all of which I trust will be found complete and satisfactory.

I commenced the survey at the north-west angle of the township of Woolrich, from which point I ran west astronomically four miles along the south boundaries of the townships of Farquhar and Haig. I then proceeded to the south-west angle of the township of Dowsley, from which point I ran the north boundary of the township of Haig west astronomically nine miles. I then returned to the south-west angle of the township of Dowsley and ran the east boundary of the township of Haig south astronomically nine miles six chains and twenty links intersecting my base line at a point three miles thirteen chains and thirteen links west of the north-west angle of the township of Woolrich. I then ran the south boundary of the township of Haig west astronomically nine miles, and from this point I ran the line between the townships of Haig and Wicksteed north astronomically nine miles four chains and two links, intersecting my base line at a point eight miles seventy-seven chains and twelve links west of the south-west angle of the township of Dowsley. I then ran the north boundary of the township of Wicksteed west astronomically nine miles. I then returned to the south-west angle of the township of Haig and ran the south boundary of the township of Wicksteed west astronomically nine miles, and from this latter point I ran the west boundary of the township of Wicksteed north astronomically nine miles five chains and eight links, intersecting my base line at a point eight miles seventy-seven chains and twenty-nine links west of the north-west angle of the township of Haig.

Substantial posts of the dimensions called for and made of the most durable wood in the locality and properly marked were planted at every mile on the base lines and at every one and one-half miles on the meridian lines, the position of each of these posts being verified by two bearing trees.

Iron posts, properly marked, were also planted at the several corners of the townships and at the end of every third mile along the lines.

Observations on Polaris at or near elongation were taken at every opportunity that presented itself, the work closing almost theoretically correct.

Along that part of the south boundary of the township of Farquhar surveyed by me, and along the whole of the south boundary of the township of Haig, and for the first two miles of the south boundary of the township of Wicksteed, the country is of a gently undulating character, covered chiefly with spruce and banksian pine up to ten inches in diameter; the soil, consisting, generally speaking, of a black loam ten to fourteen inches in depth with clay subsoil; this line crosses a number of lakes and rivers; it also crosses the Canadian Northern Railway twice and passes along five links north of the station section house at Shekak.

From the second to the ninth mile along the south boundary of the township of Wicksteed the country is of a rolling character heavily timbered with spruce up to eighteen inches in diameter, banksian pine up to sixteen inches, white birch and poplar to twelve inches. Along this line there are a few outcroppings of rock and the soil is light and sandy. The line between the townships of Haig and Farquhar runs through an undulating country timbered with spruce, banksian pine, white birch and poplar up to eight inches in diameter on the uplands, with spruce and dead tamarac swamps on the lowlands.

Along this line the soil is good black loam from ten to fourteen inches in depth and free from stone.

The country along the line between the townships of Haig and Wicksteed for the first two miles is low and swampy, and from this point up to the seven and one-half mile post the country is rolling and heavily timbered with spruce up to eighteen inches, banksian pine to sixteen inches, poplar and white birch up to twelve inches with spruce and dead tamarac swamps in the valleys. The soil is a sandy clay loam with a few outcroppings of rock.

From the seven and one-half mile post to the end the line runs through an old brulé interspersed with swamps.

The north boundary of the township of Haig and the north and west boundaries of the township of Wicksteed run, for the most part, through a very old brulé country covered with poplar, white birch, and banksian pine, interspersed with spruce and dead tamarac swamps; the soil in some places being fairly good and in other places light and sandy. There are also a few outcroppings of rock along these lines.

From the age of the timber now on the ground and other evidences there is no doubt this country was overrun by a very destructive fire about the year 1850, and at many places this fire not only destroyed the timber, but also wiped away the humus of the soil.

There are numerous lakes and quite a few large streams and rivers traverse these townships, but no water power of any note. The water of all these lakes and rivers is clear and wholesome.

The rock in this locality is of the Huronian formation, and bears no evidence of being mineralized. The Canadian Northern Railway runs through these townships. It has a first-class road-bed, is well ironed and with long tangents, and very easy grades and curves give every evidence of being carefully located and permanently constructed.

Hornepayne, a divisional point, is located in the township of Wicksteed and already forms the nucleus of a thriving settlement; here there are all told about fifty buildings and many more under construction.

I also understand that the number of children of school age is twenty-three, and that the proper steps have already been initiated to open a school.

During the greater part of the work the snow was very deep and there being no frost in the ground the travelling was very bad, and I did not explore the interior of these townships as much as I would have liked to.

From what I have seen I would consider from fifty-five to sixty per cent. of the area of these townships suitable for settlement.

The average magnetic variation I found to be four degrees and forty-five minutes west of north.

Moose and fur-bearing animals, under the present efficient administration of the Provincial game laws, are, I believe, increasing in this district.

On the timber plan submitted herewith a general idea of the location of the areas of merchantable timber may be had, but owing to the wretched travelling while on the ground it would be difficult for me to delimit them more closely.

I have the honour to be, Sir,

Your obedient servant,

(Signed) J. W. FITZGERALD,
Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 24.

Survey of Part of the Township of Keith, in the District of Sudbury.

Toronto, October 12th, 1917.

Sir,—In accordance with instructions received from your Department, dated July 31st, 1916, I have the honour to report the following survey of the north part of Keith township in the district of Sudbury.

This survey was commenced on October 11th, 1916, immediately after completion of cutting of line of the township of Muskego, adjoining on the north. The work was continued until October 26th, 1916, when, owing to extremely unfavourable weather, we were compelled to temporarily cease. That portion lying east of the line between lots 12 and 13 was completed by that date with the exception of the traverse work.

In February I returned and traversed Winter-Spawning and Slate-Rock lakes. Returning again in the month of March we were obliged to leave off in April as the extreme depth of snow rendered it practically impossible to proceed with the cutting and posting of line in a satisfactory manner.

On August 1st, 1917, I proceeded with the survey, completing same on September 11th, 1917. The work was carried out in every particular in accordance with instructions. The lines were well cut out and blazed in proper manner: durable posts were firmly planted in the ground and carved by means of a scribe. Iron posts were planted in accordance with instructions and their location shown in the field notes.

The east part of the township is generally rolling with sandy soil. The centre and western part being low-lying, consisting principally of cedar and spruce swamp, the water in these swamps being held back almost entirely by the many dams constructed by beavers. By removing dams this land would be well drained and would be found quite suitable for agricultural purposes.

The township is drained on the east side by Groundhog river, on the north by Winter-Spawning and Slake-Rock lakes, on the west by Muskego creek and Muskego lake. The water in these lakes is very clear. No rapids or swift water were found except on the Groundhog river, where at a point twelve chains south-west of where said river leaves the north-east part of the township a drop of two and one-half feet occurs. Very little water power could be developed at this point as the estimate of flow was found to be only fifty cubic feet per second. Muskego creek at the south-west corner is a small, narrow, crooked creek, being twenty-five to fifty-five links in width, where concession line 6 and 7 crosses.

With the exception of the south-east corner where fire has passed through and left little standing, the township is heavily timbered. The timber is chiefly spruce, balsam, birch, poplar and jack pine. Cedar and spruce are found more plentiful in the swamps. The timber would be suitable for pulp wood, railway ties, and lumber. The soil throughout is sandy, very little clay being found, and could be utilized for agricultural purposes.

We found very few outcrops of rock and no mineral whatever. Several outcrops occur along the line of the Canadian Northern Railway, the formation of which was schist and greenstone with an occasional showing of quartz veins.

Moose, bear, wolves, fox, mink, beaver and martin are very plentiful. Pike and pickerel were caught in the rivers and lakes.

The magnetic variation was constant, being six degrees thirty minutes west of astronomical north.

I deeply regret to report that during the prosecution of this work an accident occurred, wherein one of our party, Mr. Douglas G. Arkell, lost his life. A tree located about twenty-five feet off the line fell, striking Mr. Arkell on the head, while he was engaged cutting line. Medical attendance was at once summoned and every possible service rendered to relieve, assist and comfort the injured man. Mr. Arkell died on September 6th, while being taken to Sudbury hospital.

Herewith I enclose a general plan of survey, timber map, field notes and traverse plans, all of which is respectfully submitted.

I have the honour to be, Sir,

Your obedient servant,

(Signed) R. S. CODE,
Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 25.

SURVEY OF LINES BETWEEN LOTS EIGHT AND NINE, TOWNSHIP OF OGDEN AND LOTS TWO AND THREE, TOWNSHIPS OF BRISTOL AND THORNLOE.

NEW LISKEARD, ONTARIO, December 28th, 1916.

SIR,—We beg to submit herewith our report in connection with the survey of the timber limit in the townships of Ogden, Bristol and Thornloe, the limits of which were outlined in your instructions to us dated October 23rd, 1916.

GENERAL.

The above survey was made during the early part of December, although there was already an average of about eighteen inches of snow on the ground. Conditions, however, were quite favourable for making the survey as the ground was not sufficiently frozen to interfere with the proper placing of posts.

As instructed by you and as shown by our field notes attached herewith, durable wood posts were properly marked and placed at points where those lines will be intersected by the concession lines when run at some future time. All other conditions laid down in your instructions were closely adhered to.

TIMBER.

Generally speaking wooden conditions are similar to those found at other points along the Mattagami river. For approximately half a mile either way from

the river the forest growth is very good, spruce, of course, predominating. In some places, particularly in concessions 5 and 6 on the west side of the river, there are some large poplars. Balsam is also mixed through the spruce, but not to the same extent as is usually the case.

There are also some small jack pine areas, the most important of which lie in between the Lost and Mattagami rivers. A portion of this has been overrun by fire. The burned area includes part of concessions 2 and 3, lying west of the Mattagami river. That part of it included within the limits as run by us will cover approximately one square mile.

All that portion of the limit south of the Lost river is untouched by fire and is mostly well timbered with jack pine and spruce up to about fourteen inches in diameter.

There is also a small jack pine area in the vicinity of mining claims P 7727-6778 and 6781 where there is considerable timber suitable for railroad ties.

Approximately an area of one and one-half square miles lying north and west of the Mattagami river, in concession 5, has been burnt over. This originally was spruce bush and is now of very little commercial value. Along the line between lots 2 and 3 and across concessions 3, 4, 5 and 6, in the township of Bristol, the timber is mostly very small spruce. The same applies along our line across concession 3, in the township of Ogden.

Soil.

The entire area included by this limit will, in time, be well adaptable for agriculture. There are no rock exposures that we know of and the soil is for the most part a clay loam. That part now covered by jack pine is naturally of a more sandy nature, particularly lots 2 and 3, concession 2, in the township of Bristol.

Accompanying this report are our field notes, all of which we trust will meet with your satisfaction.

We have the honour to be, Sir,

Your obedient servants,

(Signed) Sutcliffe & Neelands,

Ontario Land Surveyors.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 26.

Survey of Certain Lines in the Township of Notman, District of Nipissing.

North Bay, Ontario, December 30th, 1916.

Sir,—Herewith we beg to report the completion of the survey of those lines in the township of Notman, as we were instructed in your letter of the date November 25th, 1916.

In each case the remains of the original posts were found from which each of the above-mentioned lines were run north astronomically. We planted new cedar posts suitably scribed in the place of these originals. Posts were also planted at the north end of each of the three above-mentioned lines.

The lines were well cut out and blazed, and carefully chained with a 200-link chain, plumbed at each end.

Accompanying this report are the usual returns, consisting of plan, field notes, and the various affidavits, together with the account, all of which are respectfully submitted.

We have the honour to be, Sir,

Your obedient servants,

(Signed) McAUSLAN & ANDERSON.
Ontario Land Surveyors.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 27.

SURVEY OF THE TOWNSHIP OF SWEENY, DISTRICT OF SUDBURY.

SUDBURY, ONT., June 28th, 1917.

SIR,—According to instructions dated May 31st, I proceeded on June 8th to the township of Sweeny to run a line dividing the township into east and west halves.

Owing to the fact that the three mile post on the north boundary was located in a marsh which is now flooded with four feet of water by beaver dams, it was necessary to check from the two mile post. The ten chain tally plugs for this mile were all located and one of the reference marks for the post found.

Owing to cloudy weather only one observation was secured.

The country in general is very rough and broken.

There is considerable white pine along the line as far as the three mile post. South of this point there is a great deal of jack pine, but it is very small. The spruce, also, is in general small.

The posts were marked according to instructions to serve when the township is eventually subdivided into lots.

I have the honour to be, Sir,

Your obedient servant,

(Signed) J. RICHARD GILL,
Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 28.

Honourable G. H. Ferguson, Minister of Lands, Forests and Mines, Toronto, Ontario:—

DEAR SIR,—I beg to report as follows with regard to advances made to settlers in Northern Ontario:—

Number of loans made to date	1,238
Amount loaned	$383,968 57
Total acreage covered by liens	190,087¼
" " under cultivation	21,303
" " ready for cultivation	4,525
" " improved land	25,828

The benefits derived from the ability of the settlers to secure loans of moderate amount on easy terms, are shown in the improved buildings, larger areas under cultivation, greater production of foodstuffs and increasing numbers of live stock owned by the settlers affected.

Generally speaking, the settlers appreciate the opportunity of securing funds on easy terms for the improvement of their holdings.

Yours truly,

F. DANE,

Settlers' Loan Commissioner.

Appendix No. 29.

ALGONQUIN PROVINCIAL PARK, November 1st, 1917.

HONOURABLE SIR,—I beg to hand you my report for the fiscal year ending October 31st, 1917.

Our staff has been composed of superintendent and thirty-three men, whose duty it has been to patrol the Park and see that the regulations are observed, to build shelter houses, cut portages and make such other improvements as may be required. During the trapping season the rangers have to be continually upon their sections to prevent poaching. Each two men have a section allotted to them which they are expected to patrol and keep in good order in every respect; this has all been done, and I am glad to report there have been no serious breaches of the law.

Conditions have been very much changed in the Park since the war. We miss the young men that used to come here for the fishing and canoeing who are now overseas serving their country. They have been replaced by their parents and friends, who seek in this health-giving region strength to bear the terrible strain natural to those whose dear ones are in such peril. As a health resort the Park is yearly becoming more appreciated, and we have a great many visitors whose sole desire is to breathe our pure air and wander about in the splendid woods of our Park. Many returned men, too, have come here to build up, and have been greatly benefitted by doing so.

The work of cleaning up along the railway has been continued, although we found it difficult to get sufficient men. However, it has been completed with the exception of two or three unimportant patches where fire had already run and destroyed the timber years ago. The piles also have been successfully burned and no damage done. This means a very great protection from fire from locomotives, and adds a great deal to the appearance of the Park when travelling through by train. One half of the expense of this work has been borne by the Grand Trunk Railway.

I am glad to report a splendid year so far as forest fires are concerned. We had none of any importance and any that did start were early placed under control. The Grand Trunk fire tank has been stationed here all season, and it is a splendid thing where a fire along the track is taken in time. Game of all kinds is very abundant and is increasing rapidly.

A view in the hardwood forests in the Algonquin Park.

We took out the regular quantity of furs, which were sold in Toronto, bringing $4,574.10. I hope next year to have a much larger number. The sale of live animals has fallen off since the war, but will, I hope, revive again when it is over. We shipped three live beaver to Lanark as directed for re-stocking the waste lands there, and I have a report to the effect that they have done well and have established themselves in their new quarters. Deer are very abundant, and I have recommended that a large number be taken out and placed on the market to help out the food supply. This, I hope, you will decide to do, as hundreds could be taken along the railways at small cost and still leave an abundant supply. I am confident, also, that from some of our large lakes a great quantity of fish could be taken if necessary.

I would respectfully draw your attention to the wood supply that could be taken from the Park, especially from the burnt area, and would recommend some steps being taken, not only to turn this into fuel for the relief of the poor in our cities, but also that something be done to derive a revenue from the vast quantity

of matured hardwood on the limits acquired by your Department. It would seem a great pity to allow this to over-mature and decay.

Nine of our men are stationed along the Canadian Northern Railway which runs through almost the entire length of the Park on the north, and opens up a splendid section which, after the war, will be much sought by the angler.

We have built a new shelter at Eagle lake, and improved and repaired several of the others. Several new leases have been granted on Cache lake and a number of good cottages erected. I think we had more people in the Park than in any other year, although not nearly so many angling licenses were sold. The boys' and girls' schools were well filled, the girls' camp being composed of some seventy people including teachers and help; the boys' schools of about forty each.

We have found our telephone system a decided convenience and a great help in cases of fire. The revenue from it is small, but had we connection with Toronto and other points as we should have, there would be a much larger revenue. At present we are confined to Orillia to the south and North Bay to the north.

We have collected and sent to the Department the following sums:

For rents	$510 00
" licenses	850 00
" live beaver	30 00
" furs	99 00
" telephone	46 59
Making a total of	$1,535 59

This does not, of course, include revenue from furs or any moneys paid at the Department in Toronto.

Trusting the coming year may bring peace and prosperity to our country.

I have the honour to be, Sir,

Your obedient servant,

G. W. BARTLETT.

Honourable G. H. Ferguson, Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 30.

QUETICO PROVINCIAL PARK.

KAWENE P.O., ONT., October 31st, 1917.

To the Honourable, the Minister of Lands, Forests and Mines, Toronto, Ontario:—

SIR,—I beg to submit my report for the fiscal year ending October 31st, 1917, on the Quetico Provincial Park, of which I had the honour of being appointed Superintendent in February, 1917.

Before the ice breaking on Eva lake I secured timber and built a shelter hut 14 x 18 sided, at Kawene station, also a small stable for our horses there. This was done with very little outlay as the lumber, windows, etc., were secured from an old shack out of repair at Eva lake.

This hut has proved a great convenience in getting supplies, etc., it being convenient to the railway station. It also served as shelter for men while putting in a telephone line and also one fire ranger on the railway track during the season. About May 1st we cut a telephone line from Kawene to headquarters, but owing to lack of material as well as the dry season we did not put in the line until later. The line is about twelve miles long, running south from Kawene to the south-westerly corner of Eva lake, thence east to French lake. The wire (insulated) is laid under the C. N. R. tracks in galvanized iron piping with boards above and below to protect it. Permission was granted by C. N. R. authorities to cross their line and also to install the telephone in the station. The line was built and the phones installed by our own staff, and I am pleased to say has not cost us any repairs whatever in its four months' use. I had a saddle trail cut along the line which will be convenient in repairing the line as well as in getting out to the station in the spring and fall seasons when the water and winter routes are closed. Shelter huts were erected on Kinippi lake, and on Lake La Croix this season. Owing to a heavy hail storm in August the roofs on huts on Eden Island, east arm of Quetico and Burntside lake were destroyed, but have since been repaired. Small additions for cooking purposes have been added to the huts on Beaver House lake and Darby's island on Basswood lake. I had built on French lake a boathouse for the shelter of gasoline boat. It is protected from "ice shoves" by a pier heavily loaded with rock and serves for protection for boat for both winter and summer. I also built one on the south side of Eva lake in the same manner for the out board motor there.

Owing to the exceptionally low water this season many new portages had to be cut on the main canoe routes and when not otherwise engaged the rangers are employed cutting inland trails. I regret to say we had considerable forest fire on the south-west end of the Park which destroyed some timber, all of which I understand will be cut this season thus lessening the loss. Considering the exceptionally dry spring season and the forest fires all around us at that time, I consider that we were very fortunate on the whole. Lumbering operations are very brisk on the south-west end of the Park, but are carefully watched by the rangers. I had erected an observation tower about three-quarters of a mile from headquarters. This tower is on a very high hill and is fifty feet in height, thus giving a good view for many miles. Preparations were made for building many others next season. Game and fur are increasing rapidly, particularly moose, red deer and beaver. Partridges are also becoming more numerous. The weather during the present month has been the roughest I ever experienced at this time of year, causing great difficulty in getting in supplies.

I have the honour to be, Sir,

Your obedient servant,

HUGH McDONALD,

Superintendent Quetico Park.

Appendix No. 31.

COLONIZATION AND IMMIGRATION.

To the Honourable G. H. Ferguson, Minister of Lands, Forests and Mines, Toronto, Ontario:—

SIR,—I have the honour to submit the following report of the Colonization and Immigration Branch for the year ending October 31st, 1917:

The following figures indicate the work of the Bureau of Colonization for that period:

School Children—Rainy River Valley.

Number of farm labourers placed		713
Northern Ontario calendars circulated		26,000
Northern Ontario booklet, "A New Land Near-by," circulated		25,000
"Ontario" handbook, circulated		5,000
"Opportunities in Ontario" (Heaton's), circulated		20,000
"Farming Opportunities in Ontario" (Farm Property Values), circulated		2,000
Maps, circulated		5,000
Railway certificates to settlers going to Northern Ontario—Adults	1,583	
Children	141	
		1,724
Number of letters received		7,244
Number of letters sent out		7,680

The farm labourers secured from the United States were generally satisfactory. Our agents had special instructions to be judicious in their selection. Had we not been careful, had we been willing to accept all applicants, we could have got two or three times as many. As it was, the number obtained exceeded the previous year by nearly a hundred.

There were 728 people who took up land in Northern Ontario last year as compared with 641 the year before. This is wonderful, considering the retarding influences of the war, especially its complete prevention of emigration from the other side of the Atlantic Ocean.

Exhibit at the Canadian National Exhibition, Toronto.

" The old log cabin has for many years been a landmark for exhibition visitors, but to the modern young men the new log cabin of the Northern Ontario Colonization Department will provide a greater amount of interest. The building itself is of timbers from this north country, hewn around Timiskaming, and within is a choice exhibit of grain, grasses, vegetables and small fruits which are produced in the same district.

A continuous stream of interested visitors passed through the building while W. G. Nixon, head of the Government Demonstration Farm at Monteith, dispensed information on the soil and possibilities of Northern Ontario in general.

International Highway—Port Arthur to Duluth.

Here is a country, he said, during an interview, which is pretty well settled in the southern portion. In the most northerly part the old settlers who have made their money out of the rich timber lands are gradually giving place to the modern and ambitious young farmer. There is already a direct line of settlers straight up through this country as far as Cochrane, but with abundance of room for newcomers. The Government is offering every facility to prospective settlers in the shape of cheap transportation, which includes settlers' effects, and 160 acres of land are offered to each settler at a reasonable sum, subject to the usual conditions."

Grown to Perfection.

Practically all grains are grown to perfection in this district, fall and spring wheat, oats, barley and peas attaining a prolific crop, especially the latter. The soil is pretty uniform all through, a clay foundation, rich in carbonate of lime, with a top covering of muck, which varies from six inches to two feet, this combination providing the nitrogenous food, phosphates and potash, necessary.

A big source of the wealth of Northern Ontario lies in its timber, the whole region being heavily wooded with spruce, white balsam and pulpwood, the timbers fetching from $6.50 to $7.00 per cord loaded on the cars.

"The climate of this region is not unlike that of Manitoba, oats ripening in fifty days, with a yield of sixty-five bushels per acre. During the three years from 1914 to 1916 seeding was commenced by the 5th of May.

A new Government demonstration farm will shortly be opened at New Liskeard, with up-to-date stock barns, and judging pavilion. The site comprises 230 acres, 60 or 70 already fit for cultivation, the rest will be cleared. An agricultural high school will be opened on the grounds.

As far north as Charlton a Government creamery has been in operation, which makes up the farmer's cream at a cost not to exceed three and one-half cents per pound. At the Monteith Demonstration Farm, 105 miles north of New Liskeard on the line of the T. & N. O. Railway, the Government have 800 acres of land, part of which is under cultivation.

Sheep-raising, near Englehart, Northern Ontario.

Purpose of Demonstration Farms.

The purpose of these farms is to produce pure-bred stock for distribution among settlers, and to demonstrate and distribute the best grains. The Matheson demonstration plant totals forty acres under oats and potatoes. Here O.A.C. No. 3 oats are grown for distribution among settlers at a nominal price. Yet another farm is at Hearst, and it is possible Cochrane may have one in the near future.

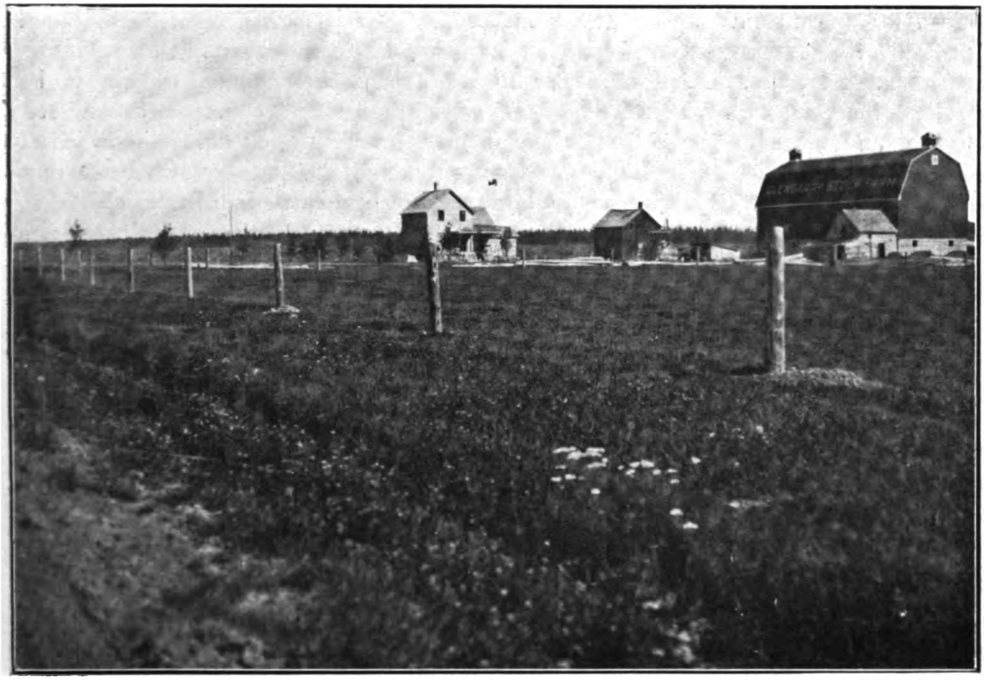
Government offices are open at New Liskeard and Monteith in Timiskaming district; at Gore Bay, Manitoulin; at Sault Ste. Marie in Algoma; at Sudbury; at Port Arthur and Fort William in Thunder Bay district; at Emo, Rainy River district, and Kenora.

The purpose of these offices is to help out the farmer in every possible way, and a ~~great work is done by the district representatives in charge.~~

"Settlers who were burnt out last year got 100 pounds of grass seed free, sufficient to cover 10 acres, and the Government loan system will enable them to purchase other seed required.

Farmers in the lower district, from New Liskeard to Englehart and Charlton, have made a success of it, and there are just as abundant opportunities in the northern portion.

Climatic conditions, changing with the clearing of the country, redound to the benefit of the settler, and there is no reason why farmers as far as Cochrane cannot be equally successful."—*Toronto World.*



Stock Farm, North of New Liskeard, Timiskaming.

EXHIBIT AT THE CENTRAL CANADA EXHIBITION, OTTAWA.

"One of the new features at the Exhibition this year that is attracting much favourable comment is the Northern Ontario Settler's Home. Situated near Howick Hall on the left of the entrance this piece of enterprise by the Department of Lands, Forests and Mines, at Toronto, is part of a campaign to bring the advantages of Northern Ontario before the people in an effective and vigorous manner. The home is tastefully laid out with two large fireplaces to insure comfort in winter, and it is one of the charms of these log buildings that, while exceedingly comfortable in the cold weather, they protect against the intense heat of summer.

Each in possession of a corner of the living room is a representative from one of the districts of Northern Ontario, proud in friendly competition with his rivals in telling of what has been achieved in agricultural production.

Kenora, the farthest west and north of the four main districts, despite the handicap of a late season, has a number of shocks of grain giving evidence of pro-

fitable cultivation. Kenora district is famous for its clover seed. Staple vegetables are brought to maturity out of doors, and on account of the plenitude of clover and wild grasses the prospects for developing an extensive bee industry are good. Dairying is starting; there is one cheese factory and two creameries that have been in successful operation for some time. The Rainy River district, which adjoins Kenora to the east, has long been known as a land of promise. This year, in addition to the cultivation of grains and vegetables, the farmers have made a success of seed potatoes and helped to supply the shortage in the older parts of the Province. In Algoma district an ambitious attempt has been made to establish a fruit district, and the results that have been secured warrant continued exploitation of the hardy varieties in that climate. The nursery at St. Joe has been doing effective experimental work. The Timiskaming district, while not the oldest, is probably the best known on account of its general farming possibilities. The experimental station at Monteith has done useful service in demonstrating to the settlers the correct farming methods and ascertaining the proper varieties of seed that should be used. In each of these districts under the encouragement of the Department the live stock industry is growing, and at Sudbury, where the industrial farm is located at Burwash, a large herd of beef cattle is being raised.

Although the building has been erected to demonstrate the agricultural possibilities of Northern Ontario, the Department has arranged an instructive display of mineral products. A sample of gold from the Croesus mine, valued at $10,000, is shown in an iron safe, while silver, cobalt and metalliferous products from the Coniagas mine and other plants in the Cobalt district give some idea of the extent of the silver industry. The Canadian Copper Company has sent samples of the copper-nickel ore that is mined in the Sudbury region, with further samples taken at each stage of manufacture until the finished product is shown. Molybdenite, iron ores, lead, mica, talc, feldspar, and a score of other minerals and metalliferous products are seen and a corps of courteous assistants are always around to give information and explain the uses to which each is put. Mr. H. A. Macdonell, Director of Colonization, is in charge."—*Ottawa Citizen.*

Almost everyone that visited the Ottawa Exhibition passed through the log cabin and received a booklet with full information on Northern Ontario.

A New Immigration Office.

Arrangements are now being made with the Dominion Immigration Department for space in the new Union Station, Toronto. We expect to be there within a year, and in that location to facilitate greatly the work of the Bureau of Colonization.

We do not prophesy, but we venture to express our belief that the war will be over before our next report is published, when emigration to Ontario will be resumed as usual, and splendid opportunities will be opened up to rich and poor, along the lines of farming, mining and other forms of prosperity.

I have the honour to be, Sir,

Your obedient servant,

H. A. Macdonell.

Director of Colonization.

Appendix No. 32.

REPORT ON THE CONSTRUCTION OF ROADS AND BRIDGES, UNDER THE PROVISIONS OF THE NORTHERN AND NORTH-WESTERN ONTARIO DEVELOPMENT ACTS, 1912 AND 1915.

(During the Season of 1917.)

To the Honourable, the Minister of Lands, Forests and Mines, Ontario:—

SIR,—I have the honour to submit to you the report of the work done under my supervision in the districts of Temiskaming and the northern part of Algoma, under the provisions of the Northern and North-western Ontario Development Acts, 1912 and 1915, from June 1st, 1917, until October 31st of that year.

Very little was done along the line of cutting out new roads except where it appeared imperative and no new bridges were built that could possibly be got along without. My efforts were confined to the building of roads and bridges that had been commenced and to the repair of others that had become well-nigh impassable.

It appears to me that it would be wise to take immediate steps to encourage the organizing of some of the townships in Temiskaming so that the Government might be relieved to some extent of the maintenance of many of these roads. Road machinery purchased and placed in the hands of organized townships, in my opinion, often serves better than making grants of money.

The following gives in detail the work accomplished:—

NEW LISKEARD, HAILEYBURY AND COBALT DISTRICT.

Haileybury and New Liskeard Road:

This road lies entirely in the Township of Bucke. This township is not able, nor has it any particular interest in maintaining this road, which forms a link in the highway between the farmers and settlers in the townships lying north, east and west of the Town of New Liskeard and the markets of Cobalt. The length of this road is 4 miles; it was graded, ditched and gravelled, several culverts were built and others repaired. The old location was poor and several diversions had to be made and one large hill greatly reduced.

North Cobalt and Lorrain Road:

This road was constructed several years ago and it had fallen into disrepair: new culverts required to be built and general repairing, ditching and gravelling was carried on for a distance of from 14 to 15 miles.

ENGLEHART DISTRICT.

In the Englehart district work was carried on in the surrounding townships as follows:

Township of Dack:

General repairing between Lots 2 and 3, across Concessions 1, 2 and 3. Building approaches to White River Bridge, Lot 8, Concession 5. Repairing road and culvert opposite Lot 3, Concession 4. Grading across Lots 1 and 2, between Concessions 5 and 6. Repairing boundary road between Dack and Evanturel, across Concession 6, and across Lots 9 and 10, between Concessions 4 and 5; across Conces-

sion 5, between Lots 8 and 9, and grading across Lots 9 and 10, between Concessions 4 and 5, and between Dack and Robillard, across Concessions 5 and 6. Grading across Concession 6, between Dack and Evanturel. Building 3 large culverts, cutting down 4 hills, ditching and grading across Lot 12, Concessions 3 and 4.

Township of Evanturel:

Building small bridge, Concession 1, building and renewing culverts, Concessions 2 and 3, all on the line between Evanturel and Ingram. Removing old bridge and building a new one over White River, Lot 7, Concession 6. Replacing old bridge with culvert and fill between Lots 6 and 7, Concession 6. Repairing wash-out opposite Lot 6, boundary of Marter and Evanturel. Building large culvert opposite Lot 4; a culvert opposite Lot 6 and grading and ditching road across Lots 4 and 5. Repairing approaches of new bridge over White River opposite Lot 6, all being on the line between Concessions 5 and 6. Repairing wash-out between Lots 11 and 12, Concession 5. Stumping and ditching across Lots 1 and 2, between Concessions 1 and 2, and ploughing road for grader. Grading and repairing culverts across Lot 12, Concessions 5 and 6, and across Concession 5, between Lots 11 and 12.

Township of Ingram:

Building culvert, ditching and grading between Lots 2 and 3, Concession 2. Chopping, stumping and ditching across Lots 1 and 2, Concession 3.

Township of James:

Building culverts, ploughing and grading across Concessions 2, 3, and 4, and stumping ¼ mile across Lot 4, Concession 4. Repairing culverts and road from Elk Lake to Moose Horn Mine.

Township of Marter:

Renewing culvert coverings and repairing the road across Lot 5, Concession 4. Grading across Concession 1, between Marter and Chamberlain. Building and repairing road across Lots 3 and 4, Concession 4.

Township of Pacaud:

Clearing right-of-way, stumping, grubbing and ditching, building culverts and grading where possible across Lot 12, Concession 2. Repairing road across Pacaud and Marquis, across Concessions 1 and 2. Removing old bridge and building new structure over Ada Creek, between Lots 4 and 5, Concession 1. Repairing road and renewing culverts between Chamberlain and Pacaud, across Lots 9 to 12, inclusive. Chopping across Lot 5, between Concessions 1 and 2. Stumping, logging and clearing right-of-way, building culverts and ditching between Lots 4 and 5, Concession 2, also across Lot 1 to the railway, between Concessions 2 and 3, and building small bridge with approaches.

Township of Robillard:

Building new culverts and cutting down hills on line between Savard and Robillard, across Lot 12 and on the line between Truax and Robillard, across Concession 1. Repairing Charlton and Elk Lake Road, across Lots 5 to 11, inclusive, in the 2nd and 3rd Concessions. Stumping, logging and laying corduroy, building new culverts, hill cutting, ditching and grading across Lots 4, 5 and 6, between Concessions 5 and 6. Ditching, building new culverts and building up road in low places across Concession 5, between Lots 3 and 4. Ditching and grading across Lot 1, between Concessions 3 and 4. Grading across Lot 1, between Concessions 3 and 4. Building new bridge and removing old structure over Sundae Creek, Lots 4 and 5, boundary Robillard and Bryce.

Township of Savard:

Repairing road, renewing culverts and gravelling in places across Concessions 1 to 6, inclusive, and grading across Concessions 5 and 6 on boundary between Chamberlain and Savard. General repairing of roads and culverts and preparing for grader, Lots 1 to 4, inclusive; building road across Lots 5 to 9, inclusive, all on line between Marquis and Savard. Grading across Lots 1 to 4, between Concessions 4 and 5, and across Concessions 5 and 6, between Lots 4 and 5. Completing road between Townships of Savard and Sharpe, across Concessions 1 and 2.

Township of Sharpe:

Building new culverts between Townships of Sharpe and Truax opposite Lot 1. Completing road across Lots 1 and 2 and stumping partly across Lot 2, between Concessions 2 and 3.

Township of Tudhope:

Stumping across Lots 7, 8 and 9, between Concessions 1 and 2.

MATHESON DISTRICT.

In the Matheson District, owing to the fire the previous year having destroyed a great number of wooden culverts, sections of corduroy and portions of the roads, which consist wholly of black muck, there being no clay available, a great deal of time was occupied and money expended in making the roads thus damaged again passable.

This section of the country is opening up quite rapidly. There is no better land to be had anywhere. Large portions of it have been entirely denuded of timber and with very little work would be ready for the plough. After the war there is no doubt the advance in this locality will be very rapid.

The work performed under my supervision was as follows:—

Township of Beatty:

Regraded one mile of gravel road across Lots 12 and 13, on the line between Beatty and Hislop. Reduced hill, regraded 4 miles and built 3 culverts on line between Beatty and Carr. Built 4 culverts on the line between Concessions 2 and 3 and reduced a hill on Lot 11. Built 4 culverts on the line between Concessions 3 and 4 and reduced hill on Lot 5.

Township of Bond:

Completed approaches to bridge on the line between Stock and Bond Townships; stumped and grubbed 30 chains between Lots 2 and 3, Concession 8; ditched 2 miles and 20 chains between Lots 2 and 3; also built 3 culverts.

Township of Bowman:

Regraded 3 miles across Concessions 4, 5, and 6; gravelled 5 chains on 6th Concession and built 4 culverts; regraded 2 miles of gravel across Lots 1 to 4, inclusive, and 4 miles across Lots 5 to 12, inclusive, on the line between the Townships of Carr and Bowman; built 1 culvert, repaired 2 others and made a fill of 200 cu. yds. on the line between Hislop and Bowman; built 2 culverts and repaired 4 others across Concessions 5 and 6 on the Trunk Road through Lot 1; built 3 bridges, each of 20-foot span, constructed 3 culverts and graded ¼ of a mile on the line between Concessions 5 and 6, across Lot 12; moved 600 cu. yds. of earth and built 1 culvert on the line between Lots 6 and 7; regraded 1½ miles and improved 20 chains of muskeg road across Concession 3. Currie and Bowman Townships: Regraded 2 miles and built a culvert on the line between Lots 6 and 7, Matheson to Wah Tay Beg; laid 20 chains of corduroy between Concessions 4 and 5; improved road between Lots 2 and 3, across Concessions 4 and 5, and part of 6.

Township of Carr:

Graded 2 miles across Lots 1, 2, and 3, between the Townships of Taylor and Carr; built 4 culverts, regraded 3½ miles and removed 2,000 cu. yds. of earth between Lots 4 and 5; built 4 culverts, regraded 1 mile and moved 200 cu. yds. of earth on the line between Concessions 2 and 3: built 11 culverts and 1 bridge and regraded 2 miles between Lots 2 and 3, through Concessions 1 to 4, inclusive: regraded 4 chains on the line between Concessions 3 and 4: regraded 2 miles and built 3 culverts on the line between Taylor and Carr Townships: regraded ½ mile between Concessions 3 and 4 and built 4 culverts.

Township of Clergue:

Stumped and grubbed 1½ miles, built 5 culverts, removed 3,000 cu. yds. of earth and gravelled 2 miles between Concessions 1 and 2: built bridge on the line between Clergue and Walker Townships; reduced a hill and widened road on Lot 12, Concession 2: built 4 culverts and repaired Trunk Road Monteith to Kelso.

Township of Currie:

Graded ½ mile in Concession 5; repaired 1½ miles of muskeg road across Lots 6, 7, and 8; built 3 culverts and replaced corduroy burned opposite Lots 9 and 11, between Taylor and Currie Townships. Stumped, grubbed and burned across Lots 1 and 2 and part of 3, between Concessions 4 and 5.

Township of Hislop:

Regraded 3½ miles from Lots 5 to 11, inclusive, and built 7 culverts between Concessions 5 and 6.

Township of Playfair:

Chopped, stumped and graded ½ mile, built 2 culverts and moved 200 cu. yds. of earth across Lot 5 on the Trunk Road from Matheson to Ramore; made a fill of 500 cu. yds. of earth approaches to Black River Bridge and 40 cu. yds. of rock for bridge piers; built 2 culverts and reduced hill across Lot 7; chopped, stumped and grubbed, and built 2 culverts opposite Lot 8, on the line between Concessions 5 and 6; chopped, stumped and grubbed between Lots 5 and 6, across Concession 5; stumped and grubbed across Lot 6, between Concessions 4 and 5.

Township of Stock:

Built 1 culvert, laid 2 chains of corduroy and graded ½ mile across Lots 6 and 7, between Concessions 5 and 6.

Township of Taylor:

Regraded 18 chains across Lot 12, Concession 5; built 1 culvert and regraded 20 chains on the line between Concessions 5 and 6; regraded 10 miles on other roads throughout the township; repaired 2 bridges, built 2 culverts and dragged 2 miles across Concessions 3 and 4, between Lots 8 and 9; built 5 culverts on the line between Concessions 8 and 9, and through Concession 4; built 2 culverts on line between Concessions 4 and 5, across Lots 5 and 6; cut, cleared and burned across Lot 12, between Concessions 2 and 3.

COCHRANE DISTRICT.

In the Cochrane District, east and west along the T. C. Ry., and south along the T. & N. O. Ry., labour was exceedingly scarce and I found it very difficult to do all the work that required to be done. The prevailing high price for pulpwood and the presence of such industries as the Abitibi Power and Paper Company, who have a very large plant and who were enlarging it, the Mattagami Pulp and Paper Company, who were employing a large number of men, and the New Ontario Colonization Company, and various lumber companies operating in the district, were all factors that resulted in the scarcity of labour mentioned.

The work performed in this district was as follows:—

Township of Brower:

Burning across Lot 6; cutting, burning and grubbing across part of Lot 5, and ditching across Lot 6 and part of Lot 5, all between Concessions 5 and 6. Cutting, stumping and grubbing between Lots 8 and 9, Concession 5. Grubbing, stumping, ditching and grading between Lots 2 and 3, across Concession 2. Built bridge over Brule Creek, and repaired culverts along the north boundary of the Township. Built bridge on Concession 2, between Lots 2 and 3.

Township of Calder:

Ditched between Lots 12 and 13, across south part of Concession 7, and between Concessions 8 and 9, across Lots 13 to 15, inclusive. Grubbing between Lots 18 and 19, across Concessions 5 and 6. Building culverts between Lots 16 and 17, across Concession 7, and between Concessions 6 and 7, across Lot 17. Cutting and burning between Concessions 6 and 7, across lots 23 to 25, inclusive. Grubbing and ditching between Concessions 4 and 5, across Lot 1. Grubbing between Concessions 8 and 9, across Lots 23 to 28, inclusive. Grubbing between Concessions 10 and 11, across Lot 16.

Township of Calvert:

Built 11 culverts, grubbed and stumped 80 chains, graded upwards of ½ a mile, and generally repaired ¼ of a mile on the Trunk Road from Porquis Junction to Iroquois Falls. Cut and burned 25 chains and grubbed 40 chains between Lots 5 and 6, across the north part of Concession 1, and between Lots 4 and 5, across north part of Concession 2.

Township of Clergue:

Repaired road between Lots 6 and 7, across Concessions 2, 3 and 4. Built 1 bridge, 4 culverts, and repaired the road between Concessions 3 and 4, across Lots 5 to 8. Repaired 7 culverts on the Trunk Road from Kelso to Monteith.

Township of Clute:

Built 3 culverts and repaired 200 chains of road on the line between Clute and Leitch Townships, west of Lot 2, Clute Township. Graded 50 chains along the same line across Lots 6 and 7. Built 1 bridge and 2 culverts between Concessions 2 and 3, opposite Lots 3 and 4. Ditching between Concessions 8 and 9, across Lots 13 and 14, and 24 to 28, inclusive. Ditching between Concessions 10 and 11, across Lots 27 and 28. Grubbing and ditching along the boundary of Clute and Calder, across Concessions 10, 11 and 12. Ditching between Concessions 8 and 9, across Lots 16 and 17. Grubbing and ditching between Concessions 8 and 9, across Lot 18. Ditching between Concessions 8 and 9, across parts of Lots 13 and 14.

Township of Fournier:

Grubbing and ditching between Concessions 5 and 6, across Lots 1 and 2.

Township of Fox:

Ditching between Concessions 3 and 4, opposite Lots 11 and 12.

Township of German:

Built 1 culvert, grubbed and stumped 10 chains, and repaired 26 chains of road between Lots 10 and 11, and 11 and 12, Concession 6, and on the trunk road across Lots 10, 11 and 12, Concession 6.

Township of Glackmeyer:

Built 4 culverts, repaired 7 culverts, and repaired 280 chains of road between Concessions 6 and 7, across Lots 13 to 22. Repaired 1 bridge between Lots 12 and 13, Concession 6. Repaired 140 chains between Lots 18 and 19, across Concessions 1, 2 and 3. Built 1 culvert and repaired 8 chains between Lots 18 and 19, Concession 3. Repaired 10 chains between Concessions 2 and 3, Lot 23, and graded 59 chains between Lots 24 and 25, Concession 2. Built 2 culverts and repaired 10 chains on the boundary between Glackmeyer and Clute, across part of Concessions 10 and 11. Built 2 bridges, Concessions 6 and 7, Lots 12 and 13. Repaired 1 bridge between Lots 12 and 13, Concession 6, and on Lot 28, Concession 8. Laid 13 chains of corduroy, stumped and grubbed 13 chains on boundary between Glackmeyer and Blount, Lots 15 to 18, inclusive.

Township of Kennedy:

Built 2 culverts, stumped and grubbed 30 chains, and generally repaired 120 chains on the south boundary of the township, across Lots 18 to 27, inclusive. Cut, burned and ditched 119 chains, stumped and grubbed 40 chains, and built 3 culverts between Lots 18 and 19, across Concessions 1 and 2. Ditched 20 chains between Concessions 2 and 3, opposite Lot 18. Built 1 bridge between Concessions 2 and 3, across Succor Creek, opposite Lot 17.

Township of Lamarche:

Built 6 culverts, removed 40 chains of corduroy, graded 80 chains and repaired 440 chains between Lots 10 and 11, across Concession 6, along the north boundary across Lots 9 to 12, inclusive, and along the west boundary, across Concessions 4 to 6, inclusive. Repaired 1 bridge, built 3 and repaired 7 culverts, and improved the road between Lots 8 and 9, across Concessions 3, 4, 5 and 6. Built 4 culverts, stumped and grubbed 25 chains, ditched 25 chains, and graded 480 chains across the north boundary of the township, from Lot 6, Lamarche, to Lot 7, Brower. Grubbed 20 chains, ditched 69 chains, between Lots 10 and 11, across Concessions 3 and 4. Cut 40 chains, burned 6½ chains, and grubbed 11 chains between Concessions 5 and 6, across Lot 4, and between Lots 4 and 5, across south part of Concession 6. Repaired 10 chains along boundary of Lamarche and Fournier, opposite Concession 12. Grubbed 79 chains and ditched 115 chains between Lots 2 and 3, across south part of Concession 4, and between Concessions 3 and 4, across Lots 4 and 5. Burned 12 chains and grubbed 13½ chains between Concessions 5 and 6, across part of Lot 4.

Township of Leitch:

Removed 30 chains of corduroy and graded 30 chains on boundary between Leitch and Blount, across Concessions 2 and 3; repaired 2 culverts and graded up to them on the same boundary opposite Concession 6. Ditched 16 chains on the Leitch and Blount boundary opposite Concession 1.

Township of McCart:

Cutting, burning and grubbing 100 chains between Concessions 4 and 5, across Lots 1 to 6, inclusive. Cutting and burning 39½ chains and grubbing 11 chains between Concessions 2 and 3, across Lot 2.

Township of Newmarket:

Cutting, burning and grubbing 18 chains between Concessions 3 and 4, across Lots 3 to 5, inclusive. Cutting 168 chains and burning 83 chains between Concessions 5 and 6, across Lots 3, 4 and 5, and between Lots 2 and 3, across Concession 6.

Township of Shackleton:

Cutting and burning 25 chains across Lot 23, Concession 12, and Lot 18, Concession 11. Cutting and burning 14½ chains across Lot 20, Concession 12. Cutting, burning and grubbing 26 chains across Lot 22, Concession 12. Cutting and burning 26 chains across Lots 15 and 16, Concession 11. Cutting 26 chains across Lot 14, Concession 11.

Township of O'Brien:

This township is being settled with the returned soldiers' and sailors' colony. About ½ a mile of railway grade for a siding was constructed, and ½ a mile of road, together with two bridges on the east side of the Kapuskasing River. Our saw-mill at Kapuskasing also operated for a short time at a cut that had been taken out the previous season. The lumber from this mill, as well as all the one inch and two inch lumber cut at Barber's Bay and Connaught, on the Porcupine Branch of the T. & N. O. Ry., was used in the buildings for the colony.

THE DISTRICT OF ALGOMA.

In the vicinity of Hearst, which is in the District of Algoma, for some reason or other, settlement has not been very rapid although the soil is excellent. The war probably has more to do with the lack of settlement than anything else. Labour was scarce here also, most of the settlers being engaged in the cutting of pulpwood. A considerable quantity of this pulpwood was shipped south over the Algoma Central Railway to the pulp mills at Sault Ste. Marie.

Work was done in the following townships in this district as follows:—

Township of Casgrain:

General repairs between Lots 24 and 25, Concession 3, and along Lots 24 to 27, inclusive, on line between Concessions 2 and 3. Repairing boundary line between Casgrain and Kendall, opposite Lots 17 and 18. Cutting and burning across Lots 14, 15 and 16, Concessions 6 and 7.

Township of Hanlan:

Cutting and burning on Trunk Road across Lots 26, 27 and 28, Concession 2. Cutting and burning on line between Lots 18 and 19, Concessions 1 and 2. Cutting and burning on Trunk Road across Lots 23, 24 and 25, Concession 2.

Township of Kendall:

Building culverts and grading between Lots 18 and 19, Concession 11. Repairing Trunk Road partly across Lots 14 and 15, Concession 10. Building culvert and grading on road across Lot 27, Concession 10. Building culvert, laying corduroy and making repairs on road between Lots 24 and 25, Concession 11.

PORCUPINE DISTRICT.

In this district most of the work was done in the Township of Mountjoy, which is the only township lying close to the Porcupine Mining Camp which has been opened for settlement. Much of the land in this township is of fine quality and there is a good market for everything produced, at the mines. The Mattagami River, which flows through this township, is crossed at the present time, during the summer months, by means of a ferry. This is not altogether a satisfactory arrangement, as there are certain seasons of the year, in spring and fall, when the river cannot be crossed, but, owing to this being a navigable stream a bridge would be an exceedingly expensive proposition, as it would have to be constructed to allow the passage of small steamboats up and down the river. As soon as conditions become normal, I would recommend that the construction of this bridge receive serious consideration.

The following is a description of the work performed in this district:

Township of Mountjoy:

On the road on the west side of the Mattagami River 3¼ miles were ditched, 1½ miles gravelled, ¾ of a mile graded and 6 culverts built. On the south side of the Mattagami River there were graded 150 rods and gravelled 180 rods; a bridge was built across the Mountjoy Creek and 3¾ miles were cut, burned and grubbed. On the east side of the river there was 1 mile cut, burned and grubbed.

In addition to the above the Trunk Road from Golden City to the Mattagami River was surfaced with gravel 1½ miles and with about 200 yards of rock. On the Hayden Road and on the road along the line between the Townships of Tisdale and Mountjoy, 2 miles of ditching, 1¾ miles of grading, ½ a mile of gravelling and 300 feet of corduroying were done. A road-drag was also used upon this road for 12 miles and 11 culverts built.

This completes the list of the work performed under my supervision from June 1st to October 31st, 1917, under the provisions of the Northern and Northwestern Ontario Development Acts, of 1912 and 1915, all of which is respectfully submitted.

I have the honour to be, Sir,

Your obedient servant,

C. H. FULLERTON,

Acting Director, Northern Development Branch, District of Temiskaming.

Dated at Toronto,
October 31st, 1917.

Appendix No. 33.

REPORT ON THE CONSTRUCTION OF ROADS AND BRIDGES, UNDER THE PROVISIONS OF THE NORTHERN AND NORTH-WESTERN ONTARIO DEVELOPMENT ACTS, 1912 AND 1915.

(During the Season of 1917.)

To the Honourable, the Minister of Lands, Forests and Mines:—

SIR,—I have the honour to submit the general report of the work done in the construction of roads and bridges, under the provisions of the Northern and North-western Ontario Development Acts, 1912 and 1915, during the season of 1917.

Operations were carried on over practically the same territory as in previous years, in the Districts of Rainy River, Kenora, Port Arthur and Fort William. Sault Ste. Marie, St. Joseph Island, Manitoulin Island, Algoma, Sudbury, Nipissing and Parry Sound, as far south as Sundridge, also in the Districts of Temiskaming in the vicinity of Englehart, Matheson and Cochrane, up to the last of May.

The work, during the early part of the season, was somewhat retarded owing to wet weather; the greater portion of the season, however, was very favourable for road construction, except that labour was difficult to procure and wages were exceptionally high; so, also, was the price of food supplies and material. The labourers employed on the work were chiefly settlers or those living in the districts. During the seeding, haying and harvesting seasons the work was postponed so as to give the settlers every opportunity of carrying on their farm work. Good results were obtained in most instances for the money expended, notwithstanding the high price of labour and supplies.

During the season, up to the 31st of October, $485,493.33 was expended on construction and repairing of roads, and purchase of plant. Approximately 275 miles of road, new and old, was worked over during the season, of which 55 miles was entirely new road, the balance being roads cut out in previous years and graded. improved and surfaced with gravel or rock: 10 miles of road was re-surfaced with crushed rock and 125 miles surfaced with gravel; 6 bridges, over 100 feet in length. and 20 bridges, over 30 feet in length, were constructed; 281 corrugated iron culverts were put in place, and 200 wooden culverts constructed. Most of the old roads built in the last five years were gone over with road drags or small graders, and ditches cleaned out.

During the season the International Highway from Port Arthur and Fort William to Duluth was opened up for traffic. Fifty miles of this road is within the Province and has been constructed and almost completed within the last four years. It is now possible for the residents of Port Arthur and Fort William to reach the larger cities in Minnesota and Wisconsin by motor car.

Five years ago it was not possible to leave the Town of Fort Frances, in the Rainy River Valley, with a motor car: it is now possible to motor from Fort Frances to the City of Winnipeg, the distance having been made in seventeen hours.

The trunk road between North Bay and Sudbury, 80 miles, was also opened for through traffic in October, the distance having been covered in three and one-half hours.

The North Bay and Bracebridge trunk road has been practically completed to Sundridge, a distance of 50 miles, and from North Bay to Mattawa, 50 miles.

These roads, and numerous other trunk roads, are constantly requiring repairs, and the cost of maintenance in the future will be very considerable. The construction of roads into the different farming sections has greatly assisted the settlers in marketing their produce, and in many cases has increased the value of their lands from $2.00 to $5.00 per acre. The construction of new roads to the different mining camps, constructed within the last six years, has added greatly to the comfort of the miners and their families living and operating in the mining districts. Perhaps the greatest benefit in the building of these roads is the opportunities it has given to the children in the rural districts of reaching schools. The construction of the many trunk and other roads during the last six years has had much to do in the opening up of the new agricultural districts along the Temiskaming and Northern Ontario Railway, and its branches, and east and west from the Town of Cochrane along the Canadian Government Railways (Grand Trunk Pacific).

Attached hereto are statements of expenditures for the year ending October 31st, 1917, in the various districts, and a summary of expenditures for the last six years.

I have the honour to be, Sir,

Your obedient servant,

J. F. WHITSON,

Commissioner.

SUMMARY OF EXPENDITURE FOR THE SIX YEARS ENDING 31ST OCTOBER, 1917.

Description.	Year ending 31st Oct., 1912.	Year ending 31st Oct., 1913.	Year ending 31st Oct., 1914.	Year ending 31st Oct., 1915.	Year ending 31st Oct., 1916.	Year ending 31st Oct., 1917.	Total Expenditure.
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Sec. 1 (a). Works and Improvements (Sewer at Hearst)....	....	....	2,100 00	....	....	....	2,100 00
Sec. 1 (b). Roads	193,082 80	1,081,172 28	791,443 08	582,914 80	513,533 75	485,493 33	3,647,640 04
Sec. 1 (d). Farms	....	....	9,035 11	8,075 68	10,125 53	18,181 52	45,417 84
Sec. 1 (e), Creamery, New Liskeard	....	....	....	....	....	15,624 86	15,624 86
Sec. 3 Seed Grain..............	....	....	....	98,920 26	24,916 63	31 50	123,868 39
Returned Soldiers' and Sailors' Settlement Act, 1917.......	....	....	....	....	....	138,812 05	138,812 05
	193,082 80	1,081,172 28	802,578 19	689,910 74	548,575 91	658,143 26	3,973,463 18
Clause 5 (Amending Act 1916) Settlers Loan Account	....	....	....	....	26.370 98	370,731 99	397,102 97
	193,082 80	1,081,172 28	802,578 19	689,910 74	574,946 89	1,028.875 25	4,370,566 15

ARTHUR E D. BRUCE,
Secretary and Accountaut.

STATEMENT OF EXPENDITURE UNDER NORTHERN & NORTH-WESTERN ONTARIO DEVELOPMENT ACTS, 1912 AND 1915.

(From 23rd May, 1912 to 31st October, 1917.)

District.	Expenditure to 31st October, 1916.	Expenditure year ending 31st October, 1917.
1. District of Nipissing and Parry Sound; North Bay to Mattawa; and east to Petawawa Military Camp, and Pembroke, and south of Callander to Powassan, Trout Creek, South River and Sundridge, and west from North Bay through Sturgeon Falls	$324,183 64	$27,184 11
2. District of Temiskaming, Haileybury, Englehart, Matheson, Charlton, Swastika, Elk Lake, Larder Lake..	487,987 94	91,254 55
3. District of Temiskaming, Cochrane, Porcupine, Iroquois Falls and Transcontinental Railway from Quebec boundary west, 125 miles to Groundhog ..	780,868 35	64,917 31
4. District of Sudbury, vicinity of the town of Sudbury and Mining District surrounding, and Sudbury-North Bay Road	234,733 96	105,602 54
5. District of Algoma, vicinity of Hearst, along Transcontinental and Algoma Central Railways	102,355 63	8,241 95
6. District of Algoma, on Sudbury and Sault Ste. Marie Trunk Road	230,766 51	34,544 37
7. District of Thunder Bay, tributary to Port Arthur and Fort William	416,813 79	40,204 96
8. District of Kenora, vicinity of Kenora and Keewatin..	169,080 27	15,024 26
9. District of Rainy River, in Rainy River Valley	327,832 16	60,594 27
10. Algonquin Provincial Park	14,391 27	347 24
11. Manitoulin Island	9,269 30	8,203 92
12. St. Joseph Island	....	12,139 17
13. Experimental Farm Plots	27,236 32	18,181 52
14. Creamery, New Liskeard	....	15,624 86
15. Seed Grain	123,836 89	31 50
16. General Administration Expenses	65,963 89	17,234 68
17. Soldiers' Settlement Account	....	138,812 05
18. Settlers' Loan Account	26,370 98	370,731 99
	$3,341,690 90	$1,028,875 25

ARTHUR E. D. BRUCE,
Secretary and Accountant.

STATEMENT OF EXPENDITURE, YEAR ENDING 31ST OCTOBER, 1917.

The Making of Roads:

Grigg, A., Deputy Minister, salary	$400 00	
Whitson, J. F., Commissioner, salary	4,500 00	
Bruce, A. E. D., Secretary and Accountant, salary	2,933 00	
Beardall, F. G., Clerk (on active service) salary	1,461 70	
Dower, A. R., Clerk (on active service) salary	988 45	
Reid, A., Clerk (on active service) salary ..	693 84	
Lawer, W. L., Bookkeeper, salary	921 63	
Laidlaw, Miss B., Stenographer, salary	766 17	
Extra Clerks	4,569 89	
		$17,234 68
Wages	$270,835 83	
Contracts	39,435 70	
Supplies and equipment	157,987 12	
		468,258 65
		$485,493 33

Advancement of Settlement and Colonization:			
Wages	$4,174 95		
Land, New Liskeard Farm	10,500 00		
Supplies, stock and equipment	3,506 57		
		18,181 52	
Creamery at New Liskeard:			
Wages	$787 69		
Contracts	8,853 00		
Supplies and equipment	5,984 17		
		15,624 86	
Seed Grain:			
Postage and expenses		$31 50	
Returned Soldiers' and Sailors' Land Settlement Act—Monteith and Kapuskasing:			
W. G. Nixon, Superintendent, salary	$743 57		
Wages	40,027 14		
Contracts	14,109 20		
Construction of training school, settlers' houses, dormitories, store and quarters, railway siding, mill, etc., equipment and supplies	83,932 14		
		138,812 05	
			$658,143 26
Settlers' Loan Department:			
Dane, F., Commissioner, salary	$5,000 00		
Kennedy, W. K. P., Accountant, salary	2,500 00		
Crawford, G., Stenographer, salary	682 33		
Taylor, N., Stenographer, salary	252 00		
Chester, Thos., Supervisor, salary	496 00		
		$8,930 33	
Net amount of loans issued	$360,078 88		
Expenses	1,722 78		
		361,801 66	
			370,731 99
			$1,028,875 25

Note.—Repayments of principal, interest, etc., $6,893.34.

Arthur E. D. Bruce,
Secretary and Accountant.

Special Warrant Accounts.

Administered by the Northern Development Branch.

Expenditure to 31st October, 1917.

$60,000 00	—Order-in-Council dated 30th September, 1916:—		
	Erection of log houses at Toronto and Ottawa Exhibitions	$3,970 73	
	Free seed grain for seeding down burnt lands	8,751 16	
	Settlers' relief stores	122 19	
	Settlers' cattle fed and looked after during winter 1916-1917	14,268 10	
	Settlers' team account, distributing lumber and supplies to settlers burnt out	1,072 68	
	Cement sidewalks	876 68	
			$29,061 54
1,500 00	—Part of Order-in-Council, 10th October, 1916—		
	Erection of schools at Matheson and Porquis Junction		1,484 92
1,500 00	—Order-in-Council dated 24th January, 1917—		
	Seeding down roads and vacant land		465 16
25,000 00	—Order-in-Council dated 20th February, 1917—		
	Purchase of cattle and other live stock	......	
	Cost of cattle purchased (220 head, including calves) and expenses in connection therewith	$19,867 70	
	Cost of rams purchased (15)	400 00	
			20,267 70

REVENUE.

	Proceeds of sale of cattle, butter, milk, etc.	$16,249 49	
	13 cows unsold.		
	15 rams unsold.		
10,000 00—	Order-in-Council dated 18th May, 1917—		
	Purchase of horses	......	
	Cost of 17 horses and expenses in connection therewith	....	3,864 18

REVENUE.

	Sale of 3 horses and refund	648 75	
	14 horses unsold.		
3,000 00—	Order-in-Council dated 18th May, 1917—		
	Returned soldiers' recreation account	....	
	Expenditure to date	....	679 84
15,000 00—	Order-in-Council dated 26th September, 1917—		
	Special fares for returned soldiers	....	
	Expenditure to date	....	508 65
			$56,331 99

ARTHUR E. D. BRUCE,
Secretary and Accountant.

NORTHERN DEVELOPMENT BRANCH.

SEED GRAIN.

Amount refunded by Settlers for Seed Grain Supplied.

October, 31st, 1915, by notes retired and cash paid	$3,171 36
October, 31st, 1916, by notes retired and cash paid	29,320 00
October, 31st, 1917, by notes retired and cash paid	18,119 04
Total refunded, 3 years ending 31st October, 1917	$50,610 40

RECORD OF CORRESPONDENCE.

For year ended 31st October, 1917.

Letters received	5,699
Letters mailed	5,442
Circulars mailed	967
	6,409

ARTHUR E. D. BRUCE,
Secretary and Accountant.

DISTRICT OF TEMISKAMING.

Vicinity of Englehart and Charlton.

Work on the construction of bridges was continued throughout the winter of 1916-17.

On the road between Concessions 5 and 6, Township of Evanturel, the bridge partly constructed the previous season, and damaged by the spring freshets of 1916, was re-constructed; the bridge is built on cedar piles and piers, the length, including abutments, is 300 feet, three spans of 60 feet clear, two spans 28 feet and one 16 feet.

The iron bridge built eight years ago on Lots 10 and 11, Township of Marter, was found to be too low and was raised six feet. New approaches were built to each end as the old approaches had been washed away during the spring freshet of 1916.

A new bridge was constructed near the village of Charlton, across the Blanche River on Lots 10 and 11, Concession 5, Township of Dack, 136 feet long, two spans of 50 feet and one of 36 feet, with stone abutments and stone-filled pier.

On the townline between Bryce and Robillard, Lot 4, a bridge was partly constructed.

The balance of the work in this district, under my supervision up to the 1st of June, consisted in re-grading and repairing old roads, constructing culverts and repairing washouts caused by the spring freshets.

MATHESON DISTRICT.

Work performed from November, 1916, to June 1st, 1917.

Kirkland Lake Road:

Hauled 654 cu. yds. of rock from Swastika to Kirkland Lake on Kirkland Lake Road.

Beatty Township:

Built two small bridges, 20 ft. span, and two culverts 3 ft. x 4 ft. x 20 ft. on Lots 9 to 13, Concessions 3 and 4.

Carr Township:

Built three small bridges, 18 ft. span, and four culverts 4 ft. x 4 ft. x 20 ft. on Lots 5 to 8, between Concessions 2 and 3.

Hislop and Beatty Townships:

Built pile bridge across Painkiller Creek on Munro Road, two 18 ft. spans and two 16 ft. spans, on Lot 11, line between Hislop and Beatty.

Stock Township:

Repaired floating bridge across Driftwood River on line between Concessions 5 and 6.

Gravelled Trunk Roads in the Vicinity of Matheson as follows:

Main Street, Matheson; to junction of Porcupine road and trunk road..	1,518 cu. yds.
From junction of Porcupine road along trunk road	583 "
From Wah Tay Beg Station to junction of townline between Taylor and Carr along trunk road	1,320 "
From junction of trunk road and Porcupine road along Porcupine road	1,340 "
From Black River bridge, Matheson, east along Munro road	5,280 "
From Munro road north on townline between Beatty and Carr	110 "
From railway crossing at Matheson along trunk road south	163 "
Town of Matheson main streets	576 "

Approximately 10,890 cu. yds. of gravel was hauled on to the trunk roads leading into the Town of Matheson, surfacing 6¼ miles of road.

Taylor and Stock Townships:

Built bridge across Driftwood River on townline between Taylor and Stock; one pile bridge with two 60 ft. spans and one 16 ft. span at each end, to replace old bridge burnt August, 1916.

Playfair Township:

Cut winter road through S. ½ Lot 5, Concession 6, 20 ft. wide, 880 yards, to enable settlers to get to Ramore Station. Built pile bridge across Black River on line between Concessions 5 and 6, Lot 3; two 60 ft. spans and two 16 ft. spans.

Benoit Township:

Built pile bridge on line between Concessions 1 and 2, 170 ft. long, across White Clay River, at Bourkes Station on the T. & N. O. Ry. Repaired Black River bridge in Town of Matheson.

TEMISKAMING DISTRICT.

Vicinity of Cochrane, East and West.

Work was commenced early in May repairing roads burnt out the previous summer. Twenty small ditching, burning and cutting of right-of-way contracts were let, in the Townships of Fournier, Clute, Lamarche, Calder, Newmarket, Fox, Shackleton, McCart and Newmarket. Besides these small contracts, five small bridges were constructed, two repaired, 14 culverts constructed, and roads re-graded and repaired. Four and one-half miles of new road was cut out and grubbed.

During the winter season a camp was at work at Barber's Bay, on the Porcupine Branch of the Temiskaming and Northern Ontario Railway, taking out bridge timber and piles: 228,500 ft. B.M. of pine was taken out and cut into bridge timber and lumber, and 130 bridge piles taken out.

The bridge and dam across the Frederickhouse River at Connaught was completed. The dam and bridge has a length of 547 ft. The dam, as now constructed, is a series of cribs filled with stone and faced with hewn timber; it is very substantial. We are now able to regulate the depth of water in the river above the

dam and on Night Hawk Lake and River, thus making the lake and river above the dam navigable for boats and small tugs for nearly 30 miles. Mining companies and lumbermen can now use this water stretch during the summer season for hauling ore, and towing logs or pulpwood.

My operations in this district ceased on June 1st.

NORTH BAY, SUNDRIDGE AND BURK'S FALLS TRUNK ROAD.

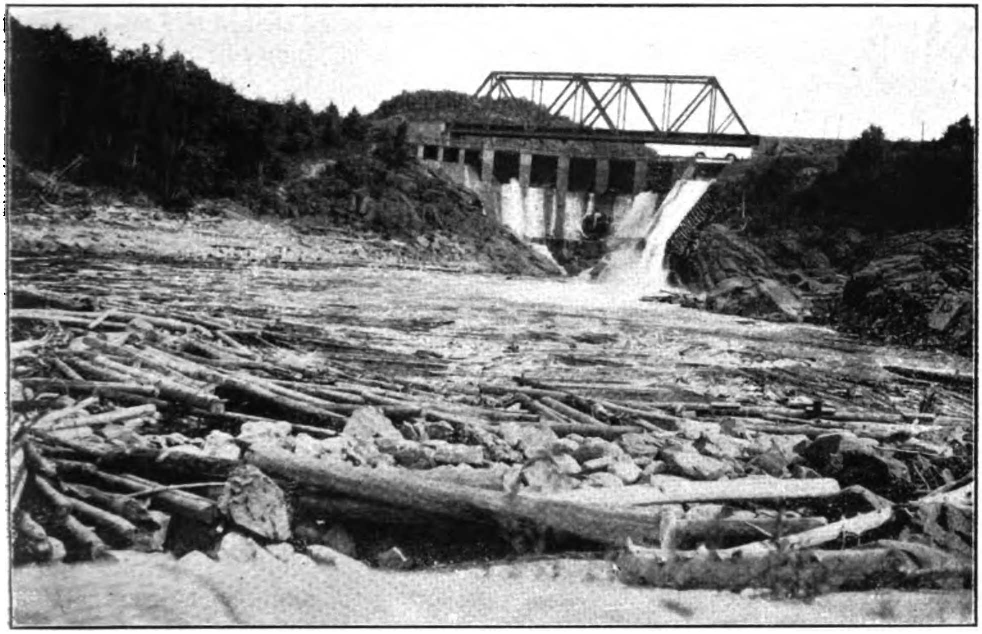
17 miles of road graded and partly cut out.
8 miles of road surfaced with gravel.
12 miles of road repaired, dragged and gravelled in places between Powassan and South River.
65 culverts placed—14 iron and balance wood and stone.
800 yards in length of tap drains dug.

Work was continued on the North Bay and Burk's Falls trunk road about the 18th of May, as soon as the settlers had finished their spring seeding. The road. with the exception of gravelling in places and other slight repairs, had been completed as far south as the Village of South River, 40 miles from North Bay, the previous season. From South River south to the Village of Sundridge, a new road was selected running south along the Grand Trunk Railway, in places, and crossing to the east of the railway, entering the Village of Sundridge from the east along the shore of Stony Lake. The new road has fewer grades than the old to contend with: it is shorter in distance. On the new road ¾ of a mile of swamp was met, which required considerable grading and ditching. The road to Sundridge is now well graded and ditched, and gravelled where found necessary. The greater portion of the road passes through a sandy or sandy loam section. The road was continued south-westerly from Sundridge for a distance of 2½ miles; two diversions to avoid bad grades were found necessary in that distance, on the old road now travelled to Burk's Falls. From the end of the road, as now finished, the present travelled road follows as good a route as is possible to select. This road requires re-grading and gravelling in places, and repairing culverts and small bridges.

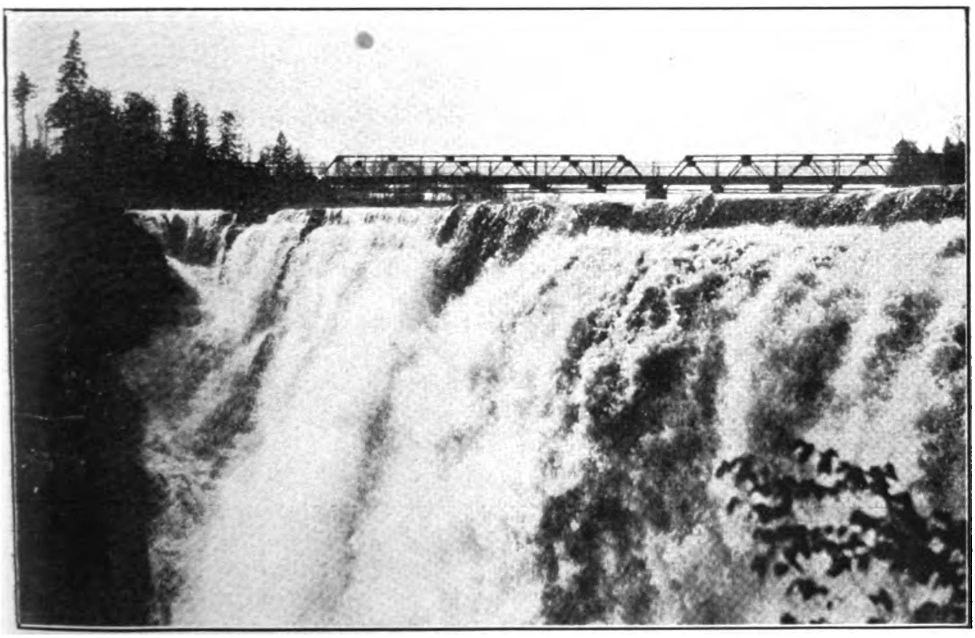
The trunk road constructed between Callander and Powassan, in previous years, and between Powassan and South River, was repaired with the road drag and small grader early in May, for 12 miles, and about 2¼ miles surfaced with gravel where most required.

In addition to the main trunk road a short trunk road was constructed along the 12th and 13th Concession line from the Village of Powassan easterly into the Township of Chisholm; the distance to the Chisholm boundary from Powassan is 5½ miles. The old road was a mere winter road in places, the country being very broken until the Township of Chisholm is entered, where there is found a considerable area of fine land and a very prosperous settlement. The road was widened and well graded for about 4 miles, and 2,200 yards of gravel placed thereon. The remainder of the road into Chisholm was repaired, but, owing to the wet season interfering, was not gravelled. Last season was not very favourable for road construction, partly owing to the amount of rainfall, but, chiefly owing to the difficulty in procuring labour; work was suspended during the haying and harvesting.

There is now a very fair automobile road from North Bay to Sundridge, the distance being nearly 50 miles. From Sundridge to Huntsville large sections of the present travelled road have never been graded, although passable for motor cars



The Espanola Water Power on the Spanish River showing Algoma Eastern Railway Crossing.



Kakabeka Falls.

during the dry seasons. A fair percentage of the country is a light sandy loam, with abundance of gravel or road material. The country along the road is fairly well settled. The repairing of this road through to Huntsville or Bracebridge would not cost a very great deal, taking into consideration the distance between Sundridge and Huntsville.

NORTH BAY AND TROUT LAKE ROAD.

The North Bay and Trout Lake Road, passing through part of the Township of Widdifield and part of the Township of Ferris, was re-gravelled and repaired during the months of June and July for a distance of 7½ miles.

PEMBROKE AND PETAWAWA MILITARY CAMP TRUNK ROAD.

The trunk road between the Petawawa Military Camp and the Town of Pembroke, graded by this Branch in 1914 and surfaced with gravel and crushed rock in 1916, owing to the heavy traffic between the Town of Pembroke and the Military Camp with motor cars and trucks—averaging during the summer months from 100 to 200 vehicles per day—became rutted in places and it was found necessary to repair this road. Screened coarse gravel from a pit at Petawawa Station was hauled by rock cars and traction engine for 8 miles over the western part of this road, and crushed rock from the Pembroke town quarry over the eastern part. The grade at the east end of the Petawawa bridge was also reduced to almost a level. The road was left in splendid condition last October; 10 miles of this road was re-gravelled.

NORTH BAY AND SUDBURY TRUNK ROAD.

Number of miles of road repaired, graded, surfaced and re-surfaced 50
of which 11 miles was graded, 16 miles surfaced with gravel, and the balance re-graded with small grader and re-surfaced in places or repaired.

Work was carried on on this road throughout the winter of 1916-17 and up to the end of October, 1917. During the winter of 1916-17 the road was surfaced with gravel in places between Wahnapitae Station and a point about 5 miles east of Markstay. One bridge, 75 ft. long, was constructed over the Veuve River 2½ miles east of Markstay; also, two bridges, 30 ft. in length, were constructed across the same stream and a tributary, between Markstay and Stinson. Grading and ditching was completed on 10½ miles between Markstay and Wahnapitae. Sixteen miles of this road was re-surfaced with gravel between Wahnapitae Station and a point 5 miles east of Markstay. Forty corrugated iron culverts were placed east of Markstay, and 75 wooden culverts constructed between Markstay and Wahnapitae. Between Sturgeon Falls and North Bay, 23 miles, repairs were made, and the road run over with a small grader, also between Verner and Warren, a distance of 17 miles. Two 40 in. corrugated iron culverts, 80 ft. and 120 ft. in length, were placed at Sturgeon Falls. At Wahnapitae Station 350 cu. yds. of rock was taken out and the road graded across the Canadian Pacific Railway Company's station

The Rotary Club, Port Arthur and Fort William, en route to Grande Marais.

A view of the Hearst range of mountains on the International Highway, Port Arthur and Fort William to Duluth.

The International Bridge between Ontario and Minnesota, across the Pigeon River, on the International Highway.

grounds. The road between Wahnapitae Station and Sudbury, a distance of 12 miles, was repaired and rolled with a ten ton steam roller. The road between Sudbury and North Bay, a distance of 80 miles, was opened for through traffic about the first week in October. There is now a good trunk road between these two towns. Settlements have been located in places along the Canadian Pacific Railway between these two towns for the last thirty years, but up to the present time there has been no communication or connection between North Bay and Sudbury by road. The road throughout has been well ditched and graded; it has few bad grades. There are still, however, a few sections that will require re-surfacing with gravel, more particularly the section between Meadowside and Sturgeon Falls and between Warren and Hagar, which will take part of a season to complete.

ROADS IN THE DISTRICT OF SUDBURY.

The Sudbury, Murray Mine and Azilda Trunk Road.—The macadamized road between Sudbury and the Murray Mine, constructed five years ago, was re-surfaced with crushed rock and rolled for a distance of 4 miles, and was continued westward for a further distance of 3 miles to the Village of Azilda, on the Canadian Pacific Railway; this road was graded five years ago. It passes through a section where the soil is either clay or quick sand. It is a road over which there is heavy traffic to the mines and from the farming country in the Chelmsford and Vermilion River valleys. Seven thousand one hundred cubic yards of rock were crushed and placed on the road and 900 cu. yds. of gravel used in the construction of the road. The road was well re-ditched, re-graded and rolled, and is now in first-class condition.

The road between Levack Station and the Village of Levack, near the Mond Nickel Company's nickel mines, as constructed last season, was completed this season. Three and one-half miles of the road was surfaced with gravel and a bridge constructed across the Onaping River, near the Village of Levack, and a second bridge across a small stream.

The Ramsay Lake and Broder Township road was repaired and surfaced with gravel in places, for a distance of 3 miles.

The road from Coniston Station to Dill Siding, Township of Dill, was repaired in places and about a mile of new road cut out and graded.

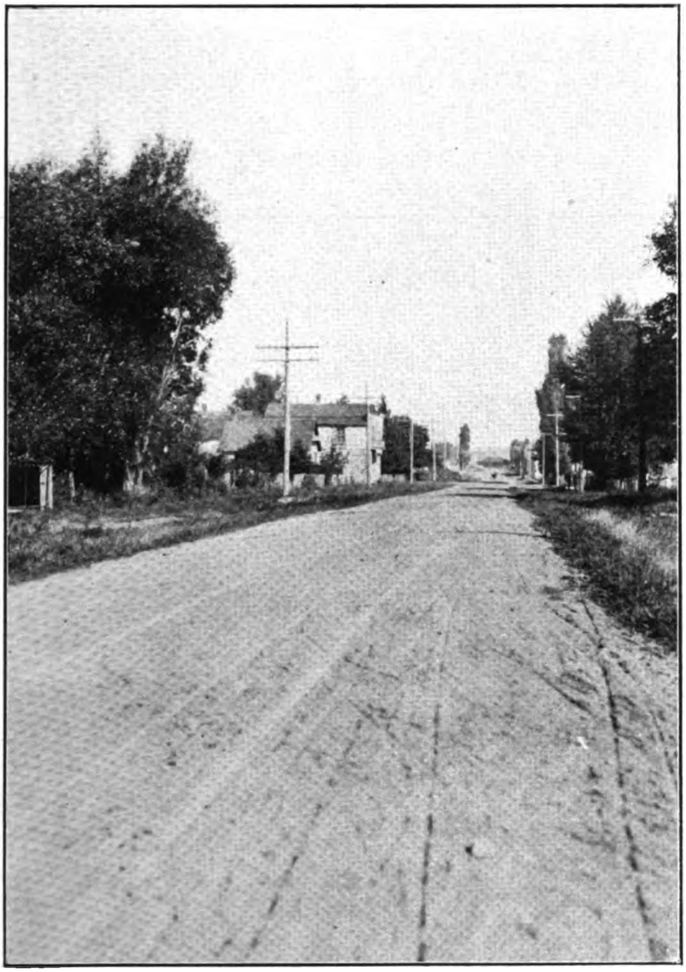
A winter road was cut out a distance of 10 miles, commencing at a point on the West Shining Tree road 15½ miles north-east of Kashbaw Station, on the Canadian Northern Railway, and running north-westerly a distance of 10 miles into the Township of Connaught, for the purpose of giving access to the copper locations about the centre of said township.

On the West Shining Tree water route a new dam was built, replacing an old one damaged by the spring freshets. This dam is used in connection with holding the water for navigation purposes between the Canadian Northern Railway and West Shining Tree.

Espanola and Webbwood Trunk Road, and Espanola Hill:

The stage road between Espanola Station, on the Canadian Pacific Railway, and the Village of Espanola, at the Spanish River Pulp and Paper Company's mills, was re-graded and re-surfaced with a heavy coat of gravel for a distance of 1⅛ miles, and the trunk road to Webbwood was re-gravelled for a distance of 1¼ miles.

The Espanola Hill from the Spanish River bridge into the Village of Espanola was cut down and a retaining wall of hewed cedar timber constructed for a distance of 270 ft, with an average height of 10 ft. The roadway was widened to a width of 24 ft. and a good substantial railing placed thereon. The hill was well graded, ditched and surfaced with gravel.



Richard's Landing, St. Joseph's Island.

Spanish River and Cutler Trunk Road:

The trunk road between Spanish River Station and Cutler Station, on the Sudbury and Sault Ste. Marie trunk, was re-graded for a distance of 6½ miles, and 4 miles of this was re-surfaced with gravel, one wooden bridge, 20 ft. span, was constructed near Spanish River Station, and 32 corrugated iron and wooden culverts were placed where required between Spanish and Cutler. Cutler is now the end of the Sudbury and Sault Ste. Marie trunk road from the east. From Cutler to Algoma Mills there is a gap of about 15 miles still to be constructed to connect Sudbury and Sault Ste. Marie.

SAULT STE. MARIE AND SUDBURY TRUNK ROAD.

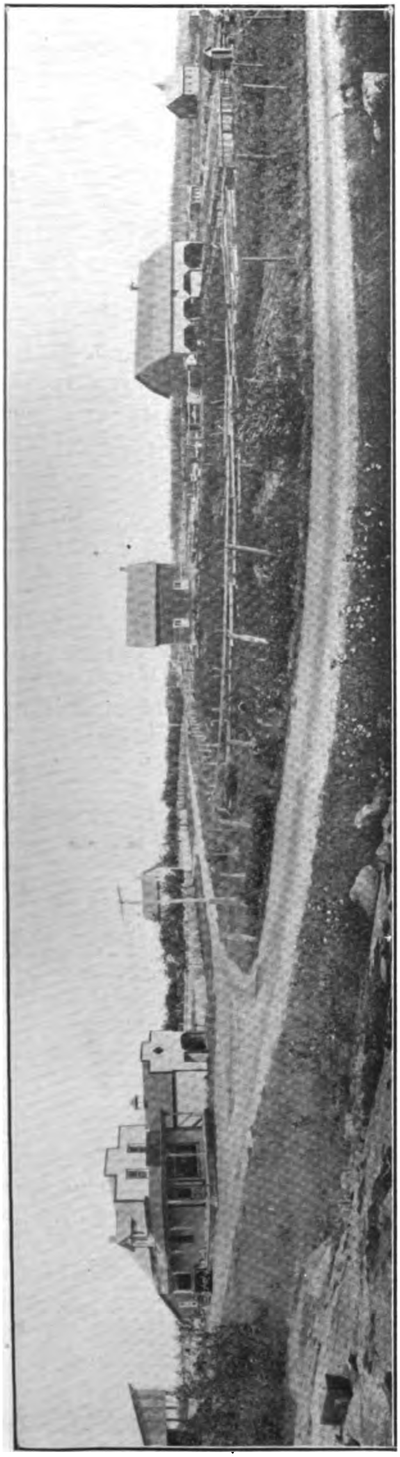
Work was commenced on the Sault Ste. Marie and Sudbury trunk road in February, 1917, at Blind River, where a bridge 375 ft. long was constructed across the west branch about 2 miles west of the Town of Blind River on the trunk road, to replace an old wooden bridge, which was unsafe for traffic. Part of the old bridge was built on piles and part on piers, all of which were in a dilapidated condition. The new bridge is constructed through its entire length, 375 ft. from shore to shore, of rock taken from the east bank of the river. About the centre of the stream a 30 ft. opening was left, sufficient to allow the volume of the stream to pass. On either side of this opening there is a crib built of white pine and filled with rock. The balance of the bridge is comprised of a rock fill, varying in depth

A section of the Sault to Sudbury Trunk Road, through the Garden River Indian Reserve. Water bound macadam.

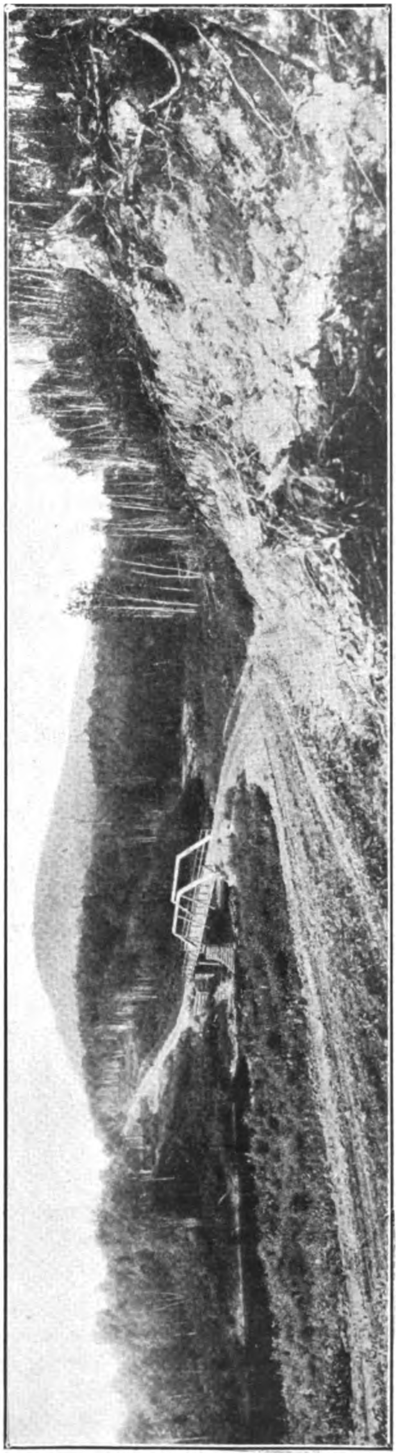
from 8 to 20 ft. as the bed of the stream in places was composed of a soft muskeg bottom. It was floored with heavy round timber 40 ft. in length on to which the rock fill was built, or dumped. The approaches to the bridge were well graded with broken rock; 4,200 cu. yds. of rock was used in this bridge.

About 4 miles west of the Blind River bridge 2,236 cu. yds. of gravel was hauled from a pit south of the Mississauga River, and placed on about 4 miles of the trunk road, which had for some time been badly in need of repair. There is still about 1½ miles of this road which requires gravelling, which could not be finished last winter before the ice broke up in the river over which the gravel had to be drawn.

During the months of June and July repairs were made to the trunk road between Sault Ste. Marie and Echo Bay, a distance of 15 miles. About a mile of this road was covered with roemac and the balance macadamized three years ago.



Trunk Road, Village of Devlin, Rainy River District.



Pine River Crossing, International Highway, Port Arthur and Fort William to Duluth.

Owing to the heavy traffic, the surface had become rutted in places and required repairing. This was done by spreading crushed rock over the surface.

East of Echo Bay, owing to the unexpected rise in the waters of the bay, it was necessary to raise the roadbed nearly one foot; 200 cu. yds. of gravel and rock was required.

Three miles of road west of Bruce Mines was re-surfaced with gravel and parts as far west as Echo Bay were repaired. This consisted of general repair work, regrading, dragging and surfacing with gravel, where found necessary, and opening up ditches, for a distance of 18 miles. One mile of this macadamized road was covered with Tarvia B, with a view to testing the cost of maintenance of such a road.

Between Sault Ste. Marie and Algoma Mills there is 102 miles of trunk road. most of which has been surfaced with gravel or stone, and is now in fair condition throughout for automobile traffic. Constant attention will be required to keep such a road in repairs.

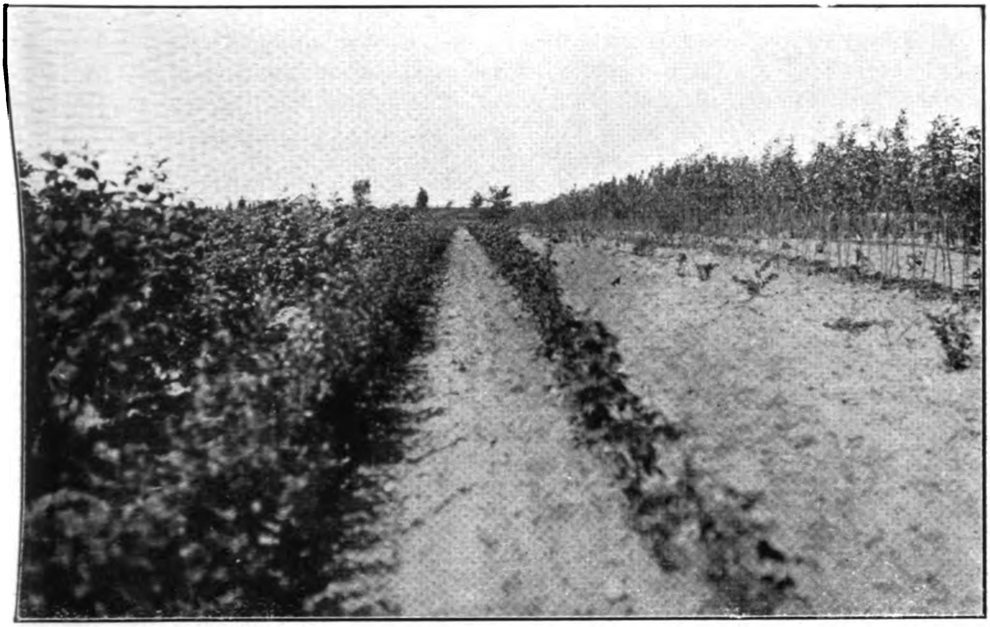
Goulais Bay Road:

The Goulais Bay road, running north from the Town of Sault Ste. Marie to Goulais River and Bay, was graded and improved this season for a distance of about 3½ miles. This work was commenced in 1916 but not finished. The road, although constructed several years ago, was in such a condition, owing to bad grades, that it was of very little use to the farmers residing in the valley of the Goulais River and at Batchawaung Bay. Three of the worst grades were improved by diversions; the road was widened, ditched, re-graded and gravelled, and is now in fairly good condition, sufficient to meet the requirements of the settlers.

ROADS ON ST. JOSEPH ISLAND.

Number of miles of road repaired, ditched and graded	10
Number of miles of road surfaced with gravel	5½
Number of corrugated iron culverts placed	20
Number of concrete culverts built	3
One small concrete bridge built.	
One cedar bridge built.	
One mile off-take drain constructed.	

In June, 1917, under your instructions, I proceeded to St. Joseph Island and made a careful examination of the main roads thereon, with a view to laying out trunk roads or improving old roads, as would best meet the needs of the settlers and assist in the further development of the sparsely settled parts of the Island. The Island has an extreme length from north to south of 18 miles, a width from east to west of 12 miles, comprising an area of 90,000 acres. The population is approximately 2,500, chiefly engaged in agricultural pursuits. About one-half of the Island is in a fair state of cultivation; the soil varies in places from a clay loam to a light sandy loam, well adapted for agricultural purposes, especially dairying and fruit growing. There are large areas with shallow sandy soil, only suitable for pasture. Judging from the many fine orchards met with, the Island is well adapted for fruit growing; there is on the Island one very fine nursery. Large herds of fine cattle are to be seen everywhere on the farms; dairying is one of the chief industries. The villages of Richard's Landing and Hilton, the former on the north shore and



A nursery on St. Joseph's Island.

An apple orchard on St. Joseph's Island.

the latter on the east, are the two most important places on the Island. At these points all the larger vessels plying along the north shore visit, and from these two points most of the farm produce grown on the Island is shipped. At these villages the settlers purchase their supplies. Wharves are to be found at different points around the shore where small saw mills operated years ago. These wharves are used by the settlers or by the tourists located on the many beautiful points along the shore.

On the Island there is approximately 100 miles of old roads cut out, a fair portion of which have been graded or partly graded, and in some instances the roads have been well drained and surfaced with gravel. The Municipal Councils and the settlers in general appear to be taking a very great interest in their roads, more so than in other sections in Northern Ontario, and are anxious to assist in every way possible in maintaining them. What they request is some assistance in the construction of a trunk road across the Island in both directions, connecting the most thickly settled portions of the Island with the two main shipping points—Richard's Landing and Hilton. After a careful examination of the Island, travelling over all the leading roads in company with members of the different Municipal Councils and others familiar with the local conditions, I found that the best interests of the community would be served if the following roads were re-graded, properly drained and surfaced or re-surfaced with gravel, which is to be found in abundance in many places with a reasonable length of haul. These proposed trunk roads pass through the most thickly settled portions of the Island and also through the best agricultural lands and along existing roads with fairly good grades and few engineering difficulties to encounter. Tributary to these proposed trunk roads branch roads can be built to all sections of the Island, or existing roads can be repaired by the different Municipal Councils as necessity demands and means will permit.

Roads selected: Commencing at Richard's Landing, thence south on side-road 10 and 11, 7 miles, to Carterton Post Office on the O and P concession road, thence west 1½ miles on the O and P line to the 5th and 6th side-road, thence south on the 5th and 6th side-road to Sterling Bay, 8 miles, thence returning to the O and P Concession west to the A line side-road, 1¼ miles, thence south and north on the A line concession, 2½ miles and 5½ miles, respectively, to the B and C concession road leading to Richard's Landing, and east along the latter 2½ miles to Richard's Landing.

The above main trunk roads to be connected with the Village of Hilton by improving either the present road to Hilton on the L and M concession line, or on the O and P line, the distance being about 6 miles. There are no engineering difficulties on either of them.

Work commenced about the middle of June on the 10th and 11th side-road; also on the A line and on the road running west from Richard's Landing to the A line. The work consisted of clearing out and straightening the old roads where necessary, re-ditching, grading and surfacing with gravel; also improving the grades on the worst hills and putting in culverts and small bridges. About 10 miles of road was graded—5½ miles of this was well surfaced with gravel, 20 corrugated iron culverts were placed, and 3 concrete culverts and one small concrete bridge constructed, also one cedar bridge; off-take drains were constructed where necessary, and the Two-Tree Creek was cleaned out for a distance of ¾ of a mile to prevent flooding of roads. This work was performed at a cost of $12,139.17.

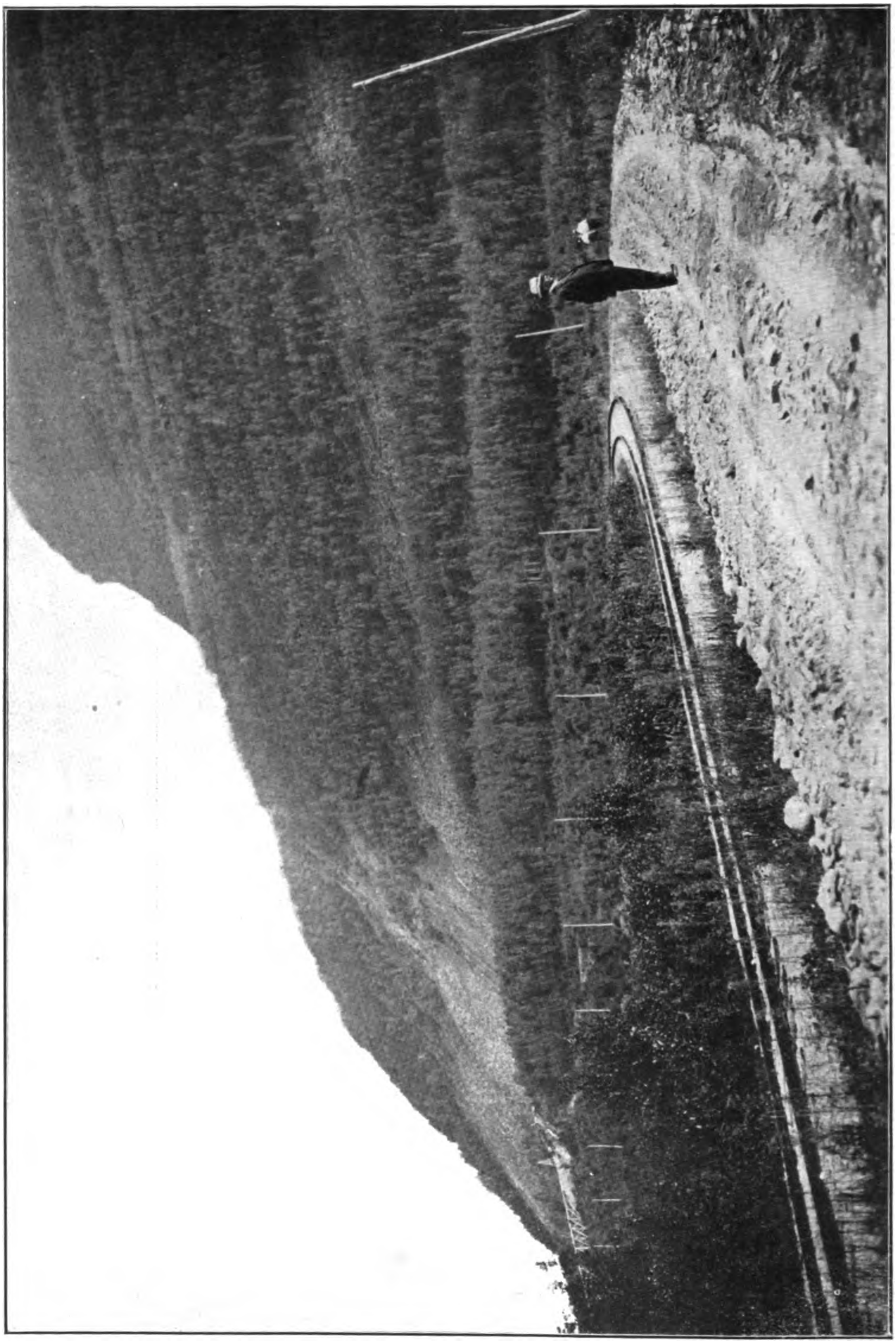
ROADS ON MANITOULIN ISLAND.

Number of miles of road graded and surfaced with gravel, 7.
1 stone bridge, 48 feet long constructed.
1 wooden bridge, 30 feet long constructed.
17 corrugated iron culverts placed.
2 stone culverts constructed.
4 wooden culverts constructed.

A view on the Trunk Road west of Kagawong, from Little Current to Gore Bay, Manitoulin Island.

Work on the Manitoulin Island, as commenced in the season of 1916, was continued throughout the summer of 1917. Work began early in June; it consisted of grading and re-surfacing with gravel about 3 miles of road beginning at Kagawong on the road between Little Current and Gore Bay to Ice Lake.

The road from West Bay south to Mindemoya was completed; 3 miles was graded and surfaced with gravel, 13 corrugated iron culverts were placed, one stone bridge, 48 ft. long, and one wooden bridge 30 ft. long, was constructed.



Mount McKay, approximately 1,200 feet high. On International Highway, Port Arthur and Fort William to Duluth.

On the trunk road between Honora and Little Current $1\frac{1}{4}$ miles was graded and surfaced with gravel.

These roads were well ditched and graded, and the finest quality of gravel placed thereon. It will take another season to complete the trunk road between Little Current and Gore Bay, a distance of 40 miles. At present the road throughout is in fairly good condition, except in a few places where it requires re-surfacing and ditching.

On the above work there was $8,203 expended; good value was received for the amount expended. The men employed were all settlers living on the Island. An attempt was made to repair the worst parts of the Little Current and Manitouaning Road, but owing to the difficulty in getting labour this work was postponed. This is the second most important trunk road on the Island. It gives to the settlers in the south-eastern part of the Island an outlet to the railway station at Little Current, and passes through sections of the country thickly settled and well cultivated. Ten thousand dollars expended on this road in grading, surfacing and repairing small bridges would put it in good condition.

ROADS IN THE DISTRICTS OF PORT ARTHUR AND FORT WILLIAM.

Number of miles of road surfaced with gravel and shale	26
Number of miles of road repaired, re-graded, graded, ditched and cut out.. of which 6 miles is new road.	46

Work was commenced in these districts about the middle of June and was continued up to the end of October; rainy weather and scarcity of labour retarded the work considerably. The heaviest part of the work was done on the International Highway, or what is locally known as the Port Arthur, Fort William and Duluth Highway, as far as Pigeon River. The southern 30 miles of this road was re-graded in places or gone over with road drag or small grader, and 22 miles of the road was re-surfaced with gravel or shale rock. The northern approach to the International Bridge at Pigeon River was completed; the approach is 75 ft. in length and 23 ft. wide. Fourteen thousand cubic yards of gravel and shale was placed thereon; 26 miles of the road was gone over with road drag and 4 miles re-graded. This road was opened for automobile traffic on the 18th of August. There is now fairly good communication between Port Arthur, Fort William and Duluth. The distance from Fort William is slightly over 44 miles, and Pigeon River to Duluth approximately 157 miles.

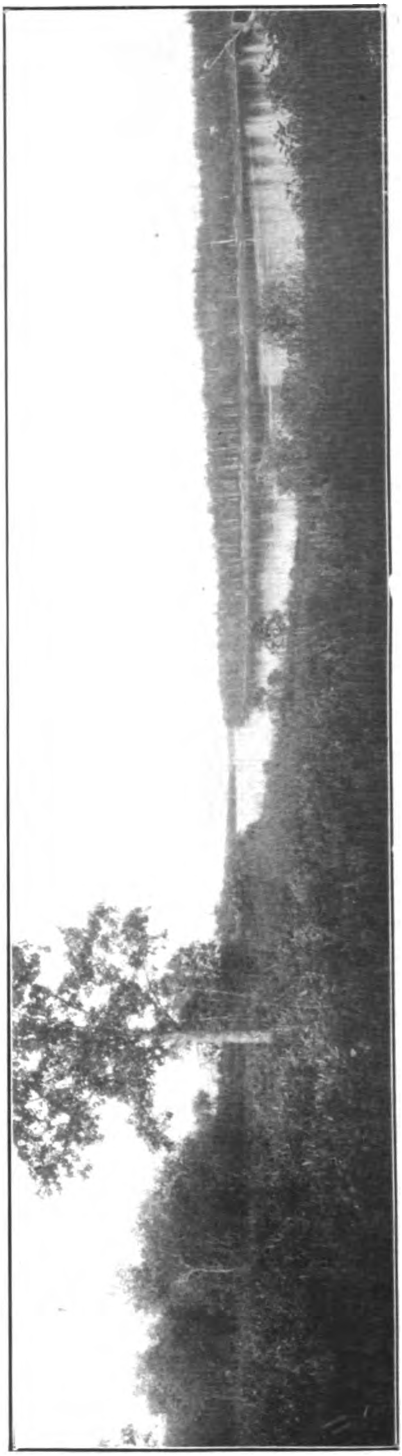
Township of Oliver:

Repair work, including re-grading and gravelling in places, was performed on the Oliver Road, Lots 10 to 17, $2\frac{1}{2}$ miles.

Township of Lybster and Gillies:

Silver Mountain Road; $4\frac{1}{2}$ miles was re-graded in the Townships of Lybster and Gillies.

A view on the International Highway, on the International Boundary, Pigeon River Cascade.



A view in the valley of the Rainy River, along the International Boundary.

Township of Gorham:

Cut out and graded road between Lots 6 and 7, across Concessions 2, 3 and part of 4; 2¼ miles.

Township of O'Connor:

Cut out and graded road across Lots 4, 5 and 6, Concession 1; 1½ miles. Ditched and graded road between Lots 6 and 7, across Concessions 5, 6 and 7; 2¾ miles.

Township of Ware:

Cut out and partially graded road across Concession 3, Lots 9, 10, 11 and 12; 2 miles.

Arthur Street, Township of Paipoonge:

Re-graded and gravelled road across Lots 25 to 30, 2½ miles, and cut out, graded and surfaced with gravel in places, new road across Lots 31, 32 and 33, Concession 1; 1¼ miles.

ROADS IN KENORA DISTRICT.

Number of miles of road partly cut out, ditched and graded	14½
of which 4½ miles was surfaced with gravel.	
Number of iron culverts placed	18
Number of stone and wooden culverts built	19
Number of bridges repaired	2

Work in this district was commenced early in June in constructing and repairing roads in the Township of Pellatt, north of Keewatin; 3¼ miles of new road was constructed and 2 bridges repaired. These roads are cut out, graded and half a mile surfaced with gravel.

The balance of the work was performed in the agricultural sections east and west of Dryden on the Canadian Pacific Railway. In this section of the country, extending from Vermilion Station east to Dyment Station, a distance of 56 miles along the Canadian Pacific Railway, there is to be found good sections of agricultural land, broken in places. The soil varies from a light coloured clay land to clay loam and sandy loam. The best section is located along the railway in the vicinity of Dryden Station and extending west to Eagle River, a distance of 17 miles, and east of Wabigoon 13 miles. In this section there are fairly large areas of good agricultural land, part of which has been settled on for nearly twenty years. Many of the settlers have made good progress. A good proportion of the country was burnt and re-burnt over many years ago and is now grown up with a small second growth timber, jack pine, poplar, birch and spruce. The land, in many places, is easily cleared.

Good colonization roads have been built in several of the townships and along the railway between the different stations. Very few miles of gravel roads have as yet been built and as the soil is chiefly clay, the roads, during the wet seasons of the year, become badly rutted and unfit for traffic. It is difficult to procure gravel

in places. I found that the main travelled road a few miles east of Dryden was partly constructed and in some places was only a mere trail or winter road. After careful examination of different roads constructed, and consultation with the settlers, I found that the best interests of the agricultural sections in that district would be served by constructing a fairly good gravel road along the concession lines paralleling or as near to the railway as possible, or adjacent to the right-of-way where practicable, following, as far as possible, existing roads. A careful survey and exploration was made from Dyment to Oxdrift, and the old roads and trails were straightened out and diversions made where required to avoid bad grades. Work was commenced at Dryden and the road cut out where required, well ditched and graded as far east as Ellen Bay, a distance of nearly 10 miles; 4 miles of the worst part of this road was surfaced with gravel. It will be necessary, however, to re-surface the balance of this road as soon as conditions will permit as the soil is nearly all a heavy clay or clay loam.

A short road was constructed west of Dryden along the line between Concessions 5 and 6 about 2 miles, and graded, to give to a small settlement an outlet to the railway.

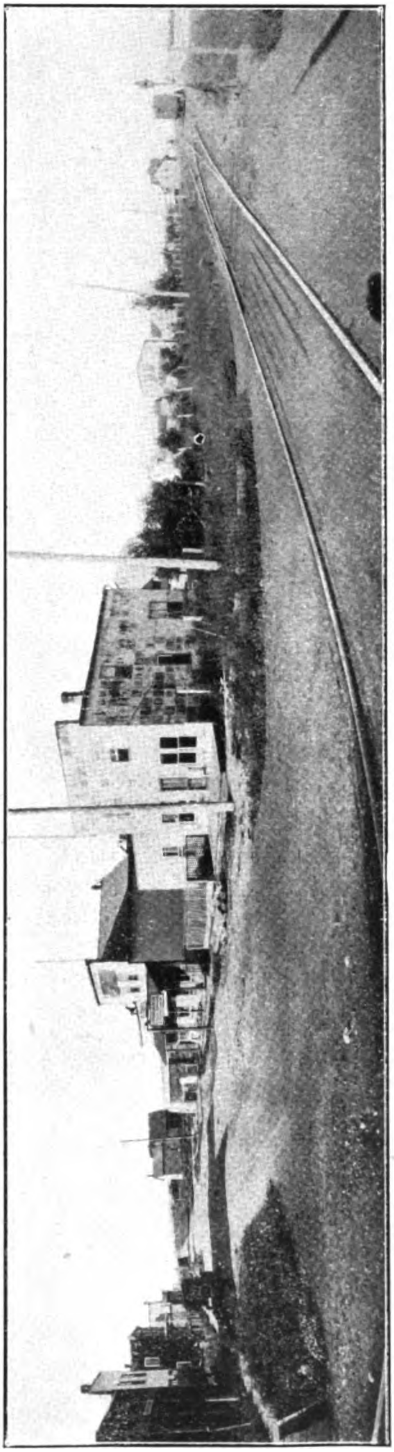
From the proposed trunk road along the railway several good colonization roads have been opened up into the agricultural townships to the north, and when the main trunk road is completed, connecting these roads with the railway stations, it will be of very great service to the different scattered settlements north to the Grand Trunk Pacific Railway. There is a very fine tract of land in this section of the district, a large percentage of which is not yet under cultivation, partly owing to the lack of more good roads and schools. The construction of a fairly good trunk road along the Canadian Pacific Railway, from station to station, will greatly relieve the situation. The character of the country is such as to warrant a reasonable expenditure on trunk roads in this particular section. The settlers as yet are comparatively poor and cannot do very much in the way of assistance, further than in the maintenance of the road. This section excels in the production of clover and timothy seed; the settlers find a ready market for their produce at the pulp and paper mills at Dryden.

ROADS IN THE DISTRICT OF RAINY RIVER.

Number of miles of new roads cut out only	23
Number of miles of new roads cut out, grubbed and graded	23
Number of miles of old roads regraded and repaired	14
Number of miles of old roads resurfaced with gravel	18.6
Number of culverts constructed	27
Number of bridges constructed	3
Number of feet of tap drains constructed	4,217

During the winter of 1917, beginning about the middle of January, several small contracts were let for the surfacing of parts of trunk roads where gravel could be easily procured and hauled more cheaply than during the summer season. As soon as the season opened up in May the main trunk roads were run over with road drags or small graders where they had become rutted late in the fall of the previous season. When the settlers had finished their seeding, small contracts were given to settlers throughout the district for the cutting and clearing of roads in the section between Fort Frances and the Lake of the Woods; these contracts numbered about thirty. A few road camps were started about the beginning of June and were

The village of Powassan, on the North Bay and Huntsville Trunk Road.



A view of the village of Stratton, on the Fort Frances and Rainy River Trunk Road and Canadian Northern Railway.

continued throughout the season. The main work consisted in the building of roads running north and south from the main trunk road between Fort Frances and the mouth of Rainy River, and the re-gravelling of parts of trunk roads. This was found necessary owing to the increase of traffic of former years. The main trunk road is now joined up by way of Beaudette, where the Canadian Northern Railway crosses Rainy River into Minnesota. There is a ferry across the river connecting the roads in Ontario with the State roads in Minnesota, which State roads extend westward and connect with the main trunk road running south from Winnipeg. It is now possible to reach Winnipeg by automobile from Fort Frances, and also reach several of the larger towns in the northern part of Minnesota. The extra amount of traffic caused by the opening up of these roads has necessitated the building of a better class of trunk roads throughout the Rainy River Valley. Tourists from the central part of Minnesota cross the International Boundary at Fort Frances and travel westward along the Fort Frances and Rainy River trunk road, re-crossing the river at Beaudette by ferry into Minnesota and proceed west and north to Winnipeg. The branch trunk roads running north and south from the main trunk road constructed during the last five years have been gravelled, and have opened up large sections of the best agricultural land in the valley.

Two creameries, one cheese factory, and one grist mill were opened up this season at Devlin, Lavallee and Emo, and notwithstanding the scarcity of farm labour throughout the district good progress is being made in clearing up new sections of land. A good class of settlers have come into the district within the last few years; in travelling through the district there is seen every indication of satisfactory progress and prosperity. There are still required, however, new roads to meet the wants of new settlements in the townships distant from the railroad and from Rainy River, townships where settlers have been located for several years with roads only passable during the dry seasons of the year. It will take at least two or three seasons yet to construct sufficient roads to meet the necessary requirements of the new settlers now located. There are few sections in the newer parts of Ontario where there is a better future, from an agricultural standpoint, than in the Rainy River Valley. The settlers find a ready market for their farm produce in the lumber camps and at the pulp and paper mills at Fort Frances, and logging camps on the shores of Rainy Lake.

Hereafter is a summary of the work performed this season:

Township of Atwood:

Re-graded trunk road across river lots 17 to 25; ½ mile.

Township of Curran:

Gravelled road east of Secs. 4 and 9; 2 miles.

Township of Blue:

Road cleared, grubbed and single ditch west of Secs. 6, 7 and 18; 3 miles. Road cleared, grubbed and single ditch north of Secs. 7 and 8; 1 mile, 1,150 ft. This road gives an outlet to settlers who have been in that part for years without a summer road, and also drains the land adjoining.

Township of McCrossen:

Cleared road allowance between Concessions 3 and 4, across Lots 1 and 2; 1 mile. Cleared road between Lots 2 and 3; ½ mile. Re-graded road between Lots 2 and 3, across Concessions 1 and 2; 2 miles. Cleared road across Concessions 6, 5 and 4, east of Lot 1; 3 miles. The above road when completed will give an outlet to a large number of settlers.

A view on the Fort Frances Trunk Road through the Manitou Indian Reserve.

Township of Morson:

Cleared road between Lots 12 and 13, across Concessions 1, 2 and 3; 2½ miles. Cleared road south of Lot 13, Concession 1; 70 rods.

Township of Nelles:

Cleared road north of Sections 5 and 6; 2 miles. One and one-quarter miles of this road was grubbed and graded. Cleared road between Sections 7 and 8; ½ mile north from the south-east corner of Section 7. Cleared road between Sections 16 and 17; ½ mile.

Township of Morley:

Re-graded trunk road north of Sections 19 and 20; 2 miles.

Township of Sifton:

Road ditched, grubbed and graded between Lots 8 and 9; ½ mile on the south half of Concession 1. Road ditched and graded between Lots 8 and 9, Concession 2; ½ mile.

Township of Worthington:

Gravelled and re-graded trunk road across river Lots 1 to 48; 3 miles.

A view at the Long Soo Rapids on Rainy River.

Long Sault Reserve:

Cleared road allowance 33 ft. wide between Lots 30 and 31; 1 mile, 13 chains. Gravelled trunk road commencing at the west boundary of Long Sault Reserve and thence east 2⅝ miles. Regraded trunk road 4½ miles across the Long Sault Reserve.

Township of Richardson:

Cleared, grubbed and partly graded road between Lots 2 and 3, Concession 1; 1 mile. Cleared, grubbed and graded road across Lots 3 and 4, between Concessions 1 and 2; 1 mile. Road cleared and low spots ditched across Lots 5 to 10, between Concessions 1 and 2; 3 miles.

Township of Potts:

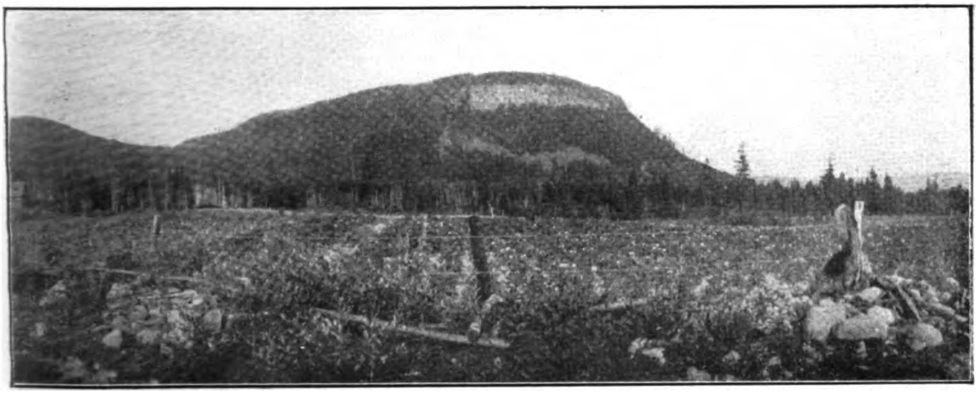
Road cleared between Lots 2 and 3, across Concessions 1, 2 and 3; 3 miles. Road cleared between Lots 8 and 9, across Concessions 1 and 2; 2 miles. Road cleared across lot 8, between Concessions 2 and 3; ½ mile.

Township of Mather:

Road cleared east of Lot 1, across Concessions 5 and 6; 1¾ miles.

Township of Kingsford:

Road grubbed and graded across Lot 3, between Concessions 1 and 2; ½ mile. Repaired road between Lots 4 and 5, Concession 2; 1 mile.



A range of mountains on the International Highway.

Township of Devlin:

Road cleared and grubbed a distance of ¾ mile and ½ mile corduroy laid, and ditched between Sections 18 and 19. Road cleared, grubbed and ditched; ⅓ mile, and 47 rods of corduroy laid west of Section 18, Devlin. Road gravelled east of Sections 2, 11 and 14; 3 miles.

Township of Lash:

Graded road between Sections 34 and 35; ¾ mile, and partly graded ¼ mile. Graded road between Sections 25 and 26; ⅓ of a mile. Single ditched road between Sections 14 and 15 and laid 90 rods of corduroy; 1 mile. Single ditched and corduroyed road north of Section 15; ⅕ of a mile. Gravelled trunk road north of Section 28 and south of Section 32; ⅔ of a mile.

Carpenter and Dobie Townline:

Road gravelled across Concessions 4, 5 and 6; 2½ miles.

Township of Burriss:

Re-graded and gravelled road between Lots 8 and 9, across Concessions 1, 2, 3 and 4, and jog on correction line; 4¼ miles.

Township of Crozier:

Re-graded and gravelled trunk road north of Sections 19 and 20; 1 mile. Road cleared and grubbed north of Sections 34 and 35; 1½ miles. Three-quarters of a mile of this road was ditched.

Township of Miscampbell:

Road corduroyed and ditched between Lots 8 and 9, Concession 3; ½ mile. Road re-graded and ditched across Lots 9 and 10, Concessions 2 and 3; 1 mile. Road grubbed, graded and ditched between Lots 10 and 11, Concession 3; 1 mile.

Township of Woodyatt:

Road gravelled between river Lots 32 and 33; 1¾ miles.

A view on the International Highway through Rose Valley along Pine River, showing the Howard range of mountains to the left, rising to a height of 1,000 feet.

Mine Centre:

Completed grading of road between Mine Centre and the Olive Mine, distance of 4½ miles. One-half mile of this road was gravelled.

Township of Carpenter:

Graded road east of Lot 1, Concession 2; ¾ of a mile.

Wild Lands Reserve:

Road commencing at the north-east corner of Section 29, and thence along the north boundary of Sections 29, 28 and 27; 2¼ miles. This road was cleared, grubbed and graded, and 2½ miles of ditch dug.

If this road is continued another mile it will give an outlet to the settlers in the vicinity of McGinnes Creek and also will open up a fine tract of land in the Wild Lands Reserve.

In addition to the above-mentioned work the trunk road between Rainy River and Fort Frances was kept dragged when necessary.

To the Honourable the Minister of Lands, Forests and Mines:—

SIR,—I beg to recommend that the following amounts be expended in the construction of new roads, repairing, grading and ditching of old roads, re-surfacing with stone or gravel of new and old roads, construction of bridges and culverts, and the improvement of waterways in the Districts of Rainy River, Kenora, Port Arthur and Fort William, Sault Ste. Marie, Algoma, Sudbury, Nipissing, Parry Sound, Muskoka, Manitoulin and St. Joseph Islands, during the season of 1918, as follows:

District of Rainy River:

In the Rainy River Valley in the construction of new roads in the partly settled townships in the northern part of the valley; the surfacing with gravel of trunk roads now graded, or partly re-surfaced: the construction or repairing of bridges and culverts $50,000

District of Kenora:

Repairing of old roads north and north-west of Keewatin and Kenora; the continuation of the trunk road paralleling the Canadian Pacific Railway east and west of Dryden Station, between Dyment and Eagle River, and the repairing of existing roads between the Canadian Pacific Railway and the National Transcontinental Railway (Canadian Government Railway) north-east and north-west of Dryden, and constructing new roads on the Canadian Government Railway 35,000

District of Port Arthur:

Re-surfacing with gravel trunk and main roads; the construction of new roads, north and east of Port Arthur, and the cutting out of a winter road into the mining section around Duck Lake, north of Schreiber on the Canadian Pacific Railway 40,000

District West and South-west of Fort William:

To complete the surfacing with gravel or stone of the International Highway between Fort William and Pigeon River (en route to Duluth), and the construction of new roads and repairing of old roads in the Townships of Conmee, O'Connor, Gillies, Lybster, Strange and Pearson, and in the new agricultural sections along the International Highway 40,000

Sudbury and Sault Ste. Marie, and Copper Cliff and Creighton Trunk Roads:

Surfacing in places with stone and gravel the trunk road between Sudbury and Sault Ste. Marie; the construction of new roads in the agricultural sections west of Espanola, north of Thessalon, and repairs to old roads; surfacing a trunk road from Copper Cliff to Creighton Mine 45,000

Manitoulin Island:

To complete the grading and gravelling of the trunk road between Little Current and Gore Bay, and to grade and gravel a trunk road between Little Current and Manitouaning 15,000

St. Joseph Island:

To grade and surface with gravel trunk roads laid out on St. Joseph Island	15,000

Districts of Sudbury and Nipissing:

To construct new roads in the agricultural sections north and south of the Canadian Pacific Railway between Sturgeon Falls and Sudbury; repairing trunk roads north of Sudbury into the Blezard Valley; improving road and water route into the West Shining Tree Mining Section; re-surfacing of parts of the Sudbury and North Bay trunk road, between North Bay and Markstay	60,000

Districts of Nipissing, Parry Sound and Muskoka:

The extension from Sundridge south of the North Bay, Sundridge and Huntsville Trunk Road; the completion of the Chisholm Trunk Road, and the repairing of the trunk road from North Bay to Sundridge	40,000

District of Nipissing:

Construction of trunk road north of North Bay through the Township of Widdifield, and improving and re-surfacing trunk road from North Bay east to Mattawa and east of Mattawa	10,000
Unforeseen work, surveys of new roads, renewing and repairing of bridges and culverts, re-surfacing and improving old roads, and the construction of short roads in sections where new settlement is taking place	30,000
Office and engineering expenses, equipment and new plant	20,000
	$100,000

J. F. Whitson,
Commissioner.

To the Honourable, the Minister of Lands, Forests and Mines, Ontario:

Sir,—For the season of 1918, under the supervision of the Northern and North-western Ontario Development Acts of 1912 and 1915, I recommend for the construction, repair and maintenance of roads, bridges and culverts, the following expenditures:

For the District of Temiskaming and Northern Part of Algoma:

Along Temiskaming and Northern Ontario Railway:

From Cochrane to Porquis Junction	$35,000
From Porquis Junction to Boston Creek	35,000
From Boston Creek to Earlton Junction, including the townships served by the Elk Lake and Charlton branches of the T. & N. O. Railway	50,000

Along Transcontinental Railway:

Along this railway from the Quebec boundary to the Town of Hearst at the junction of the Transcontinental Railway with the Algoma Central Railway, including roads for the returned soldiers' and sailors' settlement in O'Brien Township	50,000

Porcupine Mining District:

For the improvement of roads in this area and for the building of further roads in the Township of Mountjoy	20,000
Unforeseen Expenditures and Contingencies	10,000
	$200,000

All of which is respectfully submitted.

I have the honour to be, Sir,

Your obedient servant,

C. H. Fullerton,

Acting Director, Northern Development Branch, Temiskaming District.

Toronto, October 31st, 1917.

AGRICULTURAL WORK CARRIED ON IN CO-OPERATION WITH THE DEPARTMENT OF AGRICULTURE.

Ontario Government Creamery, New Liskeard, Ont.

The Ontario Government Demonstration Creamery, erected in the Town of New Liskeard during the summer of 1917, is an ideal of perfection and completeness in every detail. The Government spared no effort to make the structure permanent with a view of establishing a manufacturing centre for the manufacture of creamery butter of the best possible quality.

New Liskeard was chosen as the location on account of railroad and market facilities. A site was bought near the station and work commenced, and in August the plant was put in operation under the direction of A. MacLachlan, a graduate

butter-maker of the Ontario Agricultural College, and a man of wide experience in the business. Owing to the fact that it was somewhat late in the season when the plant was put in operation, not so many farmers patronized it as would have had work commenced early in the spring. However, results were better than expected and those in charge were well satisfied. The creamery is to be in operation all winter (this was not expected) which goes to prove that the farmers are falling in line and are well satisfied with results. Inquiry among the farmers sending cream to the creamery, as to what their opinion is regarding the scheme is usually answered thus: "I am exceptionally well pleased with results." "I believe in the creamery to this extent that I am going to add as many more cows to my herd as I can." "My wife never wishes to make butter again." "My cows are making me more money than when we churned the cream at home."

With the spring flow of milk the quantity of cream will increase greatly. Then there are many new patrons preparing to send cream and as the manager's slogan is "Once a patron, always a satisfied patron," there is little chance of many, if any, farmers quitting.

The following figures shows business to November 30th:

Operations were started on August 18th, and up to the 31st we took in 7,016 pounds of cream, producing 1,852 pounds of fat, making 2,342 pounds of butter for which we received $989.29, and paid patrons for cream $830.10 at the rate of 45c. per pound fat.

From September 1st to September 30th we took in 12,570 pounds of cream, producing 3,520 pounds of fat, making 4,354 pounds of butter for which we received $1,867.70, and paid patrons for cream $1,669.00 at the rate of 48c. per pound fat.

From October 1st to October 31st we took in 11,327 pounds of cream, producing 3,187 pounds of fat, making 3,890 pounds of butter for which we received $1,728.59, and paid patrons for cream $1,567.54, at the rate of 49c. per pound fat for first half and 50c. per pound for last half.

From November 1st to November 30th we took in 6,172 pounds of cream, producing 1,660 pounds of fat, making 1,884 pounds of butter for which we received $902.41, and paid patrons for cream $836.95, at the rate of 50c. per pound fat.

Making total for three and one-half months of:

Thirty-seven thousand and eighty-five pounds of cream, 10,219 pounds of fat, 12,470 pounds of butter, $5,487.99 cash received for butter, $4,903.59 paid out to patrons; an average price per pound fat, 47.98; number of patrons sending cream, 65. This number will be more than doubled for 1918, and almost every person who patronized the creamery the past season is increasing his herd, and some have already doubled them.

At the present time we are taking in 1,500 pounds of cream per week, making about 500 pounds of butter.

In conclusion I beg to state that the putting of a creamery in operation in the Town of New Liskeard for the benefit of the farmers of the lower end of the district is materially, in a financial way, helping—by providing an outlet for all the cream they are prepared to produce. It is now up to the farmer. There can be no doubt about the future of the business; good and ample market is already in the district for all the butter that can be produced.

Sale and Distribution of Cows Through Timiskaming District, 1917.

During the early spring of 1917, at the time when the Government decided to erect a creamery in New Liskeard, the Government was approached by a number of farmers interested in stock (milch cows) and who desired to purchase good grade cows, to ascertain the chances of having a few carloads bought and sold in the district. The Government decided to comply with the request and bought three carloads of grade cows, milkers, springers, etc. These were shipped to New Liskeard and sold by public auction (to farmers only) on April 13th. Farmers came from as far north as Cochrane to attend the sale. Forty-three head were sold and, as the buyers were located all along the line of the Timiskaming and Northern Ontario Railway, the Government decided to ship freight prepaid to the buyer's nearest station.

The interest taken in the sale induced the Government to carry on, and in the early summer nineteen more head of milch cows were shipped to New Liskeard and eighteen head to Monteith. These were advertised for sale at cost price, the farmers paying transportation from place of buying to their own farms.

Despite the fact that all good milch cows are very high in price and hard to buy, the Government was able to pick up a good average lot of cows of grade Ayrshire and Shorthorn type.

The auction sale of April 13th gave very creditable results, the cows selling for a price sufficiently high to cover purchase price and transportation. The private sale of those shipped in later worked out just as well as expected; buying was naturally more deliberate and extended over a few months' time. All cows were sold for cash at time of sale, the reason for so doing being that the new Government Loan Scheme, whereby a farmer of good standing may borrow up to $500.00 from the Government for the purpose of buying stock and otherwise improving his farm made it possible for needy farmers to get the necessary cash to buy stock with.

In addition to buying cows, the Government also bought a few carloads of horses and shipped them to New Liskeard and Monteith to be sold to settlers at cost. The demand for horses did not prove as great as expected, so that only the one lot was sent in. The purchase of good stock, to be sold to the settlers at cost, is a very creditable line of work and one to be followed up.

In the districts west of the Great Lakes the farmers are taking a much greater interest in live stock. This increased interest is largely due to the development of dairying and their appreciation of the importance of live stock in keeping up the fertility of their farms. In these districts the Government sold at auction for cash forty-three cows at Port Arthur, seventeen at Kenora, eighteen at Dryden and forty-three at Devlin.

In Muskoka and Parry Sound Districts sheep raising is becoming a very important industry, but the farmers are seriously handicapped by the fact that there are very few breeders of pure-bred stock. Realizing the difficulty the Government purchased thirty pure-bred rams and sold them at cost to the farmers.

The results of efforts on the part of the Government in assisting the farmers along live stock lines have been very encouraging indeed. It has enabled farmers to get good stock at reasonable prices and will undoubtedly have a very desirable influence upon the building up of the live stock industry of Northern Ontario.

The Establishment of New Liskeard Demonstration Farm.

In the fall of 1916 the Government, under Hon. G. Howard Ferguson, Minister of Lands, Forests and Mines, decided to establish a Demonstration Farm at New Liskeard. The Town of New Liskeard donated 70 acres of land, 30 of which is cleared. In addition, the Government bought 160 acres of wooded and slashed land, making a total of 230 acres of unbroken, tillable land. All but 80 acres is within the town limits and ideally located for farmers visiting the town either by train or vehicle. The soil varies from sandy loam to clay and is quite characteristic of the average soil of the New Liskeard farming community and north to Englehart.

The farm is to be strictly a demonstration farm for the purpose of testing out the different kinds of field and root crops most suitable to the district. It is also the aim of those in charge to produce seed of first-class quality for sale to farmers throughout the district. These lines of work, properly carried on, cannot help but stimulate and benefit New Ontario agriculture, because of the fact that conditions are different to those of the older part of the Province where we have a more permanent agriculture. Somewhat short seasons demand close attention to soil cultivation, seed, varieties and methods of seeding. These are things the Government plan to take up on this new farm.

It was too late in the fall of 1916, when the farm was taken over, to do any work on the cleared part of the farm. Work was commenced in the spring, but it was found that, on account of the land having been a commons for years, it was infested with all kinds of weeds and would need to be summer-fallowed, at least it was considered advisable to do so.

One acre was given over to the pupils of the Continuation School for garden work. This they planted to potatoes, doing all work under the direction of the local office of the Department of Agriculture.

A part of the land summer-fallowed was put in shape for fall wheat and a small acreage sown to Dawson Golden Chaff the last week in August. It showed up very well in the fall and should winter through all right.

Plans of up-to-date farm buildings are being prepared, and will be erected at an early date. At least twenty-five head of high-class pure-bred dairy cattle will be kept and other kinds of pure-bred stock as well. Good young stock will be reared for sale to farmers throughout the district. Owing to the fact that time has not permitted the erection of proper farm buildings, stock on hand consists only of one team of Clydesdales, and one pure-bred imported Yorkshire boar held for service.

In addition to the farm buildings the Government propose to erect an up-to-date Agricultural High School and already a very commodious Judging Pavilion and Assembly Hall has been erected and is now in course of completion. This building will be used for short course work in the judging of all kinds of live stock and seed. Courses embracing every feature of farm and domestic science work will be taught and demonstrated in the school and hall. All this bespeaks a new and greater interest in New Ontario agriculture, the benefit of which will only show in the years to come.

It is the intention of the Government to put the farm in full operation as soon as possible and make it a producing institution. Considerable attention will be given to the best varieties of potatoes to plant and the most suitable methods of planting with a view to carrying out the Government's scheme to make New Ontario a seed producing country.

Many important lines of work are to be carried out relative to helping perfect Timiskaming agriculture.

Matheson Demonstration Farm.

Immediately south and across the T. & N. O. from the town the Government has reserved a lot for farm demonstration purposes. In the fall of 1916 thirty-five acres were plowed and made ready for spring cropping. It was decided to seed all but three acres to O.A.C. No. 3 oats, a variety especially well adapted to conditions in the district. Results were most encouraging, considering the very unfavourable spring season which delayed seeding from two to three weeks as compared with the three previous years. In 1914-15-16 seeding commenced on the 5th of May, but in 1917 it was the 21st before it was possible to commence seeding operations and, although the weather following was not very favourable, the grain came along well. It ripened in approximately ninety days from date of seeding and was not at all affected by the early fall frosts of Aug. 20th and Sept. 6th. There was a yield of fifty-five bushels per acre of well matured, plump, bright grain. After threshing the grain it was shipped to the Government farm at Monteith, where it will be thoroughly cleaned and made ready for distribution to settlers at a nominal price per bushel.

The entire farm was seeded down to clover, a part of which is to be left for seed and hay growing purposes. The seeding of clover with all grain is a practice the Government makes for the purpose of adding fertilizer to the soil and increasing the humus content. About one-third of the farm was fall plowed for next spring's crop, the balance being left in hay.

Three acres were planted to potatoes but results were not very satisfactory on account of the bad season. Nowhere in the district did potatoes do well last summer as compared with previous years. Lack of sunshine, cold, damp weather being the cause, coupled with the fact that seeding was unusually late.

At Matheson, as elsewhere along the Timiskaming and Northern Ontario Railway, the Government plans to demonstrate what can be done in the production of field crops by using varieties that are suitable to climatic conditions.

Cochrane Demonstration Plot.

In the fall of 1917 some ten acres of slashed, unstumped land were taken over by the Government. The plot is a part of the agricultural grounds lying north and west of the town. It is the intention of the Government to proceed with the clearing and fencing of this plot of ground in the spring of 1918. Small demonstration plots of the different kinds of staple grains and root crops will be planted from year to year by way of proving the possibilities of the country from an agricultural standpoint.

Soldiers' and Sailors' Training School, Monteith.

The Land Settlement Scheme for the placing of returned soldiers and sailors on the land was put in operation in the spring of 1917. The establishment of a training school on the Government Demonstration Farm, Monteith, was decided upon, and, in order to provide immediate accommodation, temporary quarters were erected in the spring. The building was made to house thirty men. The dormitory, arranged hospital fashion, was equipped with single beds, mattresses, sheets, blankets, pillows, etc. A large living-room, adjoining the sleeping quarters, provided a place of recreation. In this was placed a billiard table, piano and gramophone, for the use and pleasure of the men. Kitchen, dining-room, storehouse,

baggage-room and laundry were built to fully provide for the comfort of those in training.

On June 14th the first lot of men arrived, twenty-seven in all. Some of them were men with farm experience, while others had never worked a day on a farm. In view of this fact we were not surprised to find that, as time passed by, some of them decided that it would not be in their own best interests to carry on with the scheme. Any man deciding to quit was provided with free transportation back to his home. On the whole, the majority of the men showed an interest in the work and were willing to do their best. Certain conditions, peculiar to pioneer life, at times caused some of the men to wonder as to the advisability of staying with the scheme, but, as they became more accustomed to the work and more interested, these difficulties did not appear so formidable.

The men are required to do all kinds of farm work and are entitled to receive lectures of a practical nature on the most important farm subjects. Practical foremen are placed over the men to instruct them in the best methods of land clearing, bush work, care of stock, etc. While in training the men are paid a wage equal to current wages.

By way of making permanent provision to look after the agricultural welfare of those desiring to take advantage of the scheme, a large and thoroughly up-to-date building is being erected. This building will have accommodation for sixty men and is provided with all modern conveniences. No effort is being spared on the part of the Government to make things as comfortable as possible for the men. A rather extensive scheme is being planned whereby this new school may be used in future years as a place of instruction and education, where the holding of short courses in agriculture and domestic science, for the benefit of Temiskaming settlers. will take place.

During the past summer sixty men passed through the regular course of training. Of these, thirteen decided to give up the scheme, as they considered it would not be in their own best interests to follow it through. The other forty-six have decided to go on to the Colony Farm at Kapuskasing, where a large tract of land is held, in 100-acre lots, for settlement. At Kapuskasing the men are settled on farms which in time become their own if they qualify and fill required regulations.

Naturally, on account of the scheme being a new thing, it will take time to work out all details so that it may be carried on in the best possible interests of the men in training. Those in charge have had to look after considerable work in connection with the improvement and building of new farm buildings. The completion of these will allow closer attention to details in the carrying out of work regarding the men in training.

While pioneer conditions still exist in the upper part of the district and settlers are required to put up with many inconveniences, the substantial way in which the Government is prepared to help all returned men desirous of taking advantage of the scheme, will entirely eliminate many hardships which the average settler has to put up with. Much, of course, depends on the men themselves as to whether they become successful in the scheme. The Government is making it possible for them to help themselves and, in so doing, have substantially provided means of looking after all important matters connected with the successful carrying out and completion of the scheme. Time alone will show results, which, because of the fact that the soil of the Clay Belt is fertile and productive, leaves little doubt but that they will be advantageous to those most vitally concerned.

C. F. BAILEY,

Assistant Deputy Minister of Agriculture.

Appendix No. 34.

REPORT OF FORESTRY BRANCH, 1917.

SIR,—The work of the Forestry Branch for the year ending 31st October, 1917, can be conveniently reported under three headings, viz., I. Forest Protection, II. Reforestation, III. Tree Diseases.

I. FOREST PROTECTION.

(1) *Legislation.*

The protection of forests from fire in 1917 was carried on under the authority of new legislation, *The Forest Fires Prevention Act*, which embodied the modern features which experience has shown to be desirable. In brief, these were the permit system in respect to the setting out of fire within a close season, power to compel the cleaning up of fire hazards, and provision for the usual safeguards in the use of engines, mill waste burners, etc. The Act provided for the appointment of a Provincial Forester for its administration.

(2) *Organization.*

The area protected was divided into thirty-four districts, each in charge of a Chief Ranger. Chief Rangers were assisted in their inspection work by one or more deputies according to the number of rangers working in their territory. Over the Chief Rangers were three territorial Inspectors, with headquarters at North Bay, Cochrane, and Nipigon; and the general field work was supervised by a Superintendent for the Province.

The number of rangers appearing on the monthly paylists was: April, 84; May, 828; June, 972; July, 1,042; August, 1,020; September, 885; October, 59. Of this total, the maximum number of rangers employed during any one month exclusively on Forest Reserves and Provincial Parks was 290; a portion of the area is under license. The cost of patrol on reserves and parks was $88,752.25, and outside these $277,372.84.

The increased number of men required in the new organization was due to several factors, namely, the addition of rangers on licensed lands, the introduction of the permit system and the placing of protection on areas where none had previously existed.

(3) *Patrol Area.*

An increase in the number of rangers employed was necessitated by an Order-in-Council of April 16th, 1917, imposing an annual fire protection charge of $6.40 per square mile or fraction thereof on all timber berths or limits under license or permit, and on all pulpwood or timber concessions covered by agreements.

The total area under protection approximated 100 million acres. In addition to Crown Lands, licensed and unlicensed, protection was furnished at the request of the owners to 680,000 acres held in fee simple, the cost of which was borne entirely by them.

(4) *Fires.*

The weather in the earlier part of the fire season was dry. This was particularly the situation in the north-western area of the Province, many sections not receiving any rain till near the middle of June. In consequence, many fires occurred in this region, some of which got beyond control and burned over large areas. For the remainder of the season, on the whole, the weather was wet and the hazard low, till the second week in September when a second dry period set in, especially in the east.

Fire Summary, 1917.

1. Number of fires reported:

1,110, of which 759 had occurred before July 1st.

2. Causes:

(a) Settlers clearing land	91
(b) Neglected camp fires	154
(c) Railway operation	549
(d) Lightning	32
(e) Logging operations	46
(f) Miscellaneous (known)	40
(g) Unknown causes	198

3. Areas:

(a) Timber land, mainly coniferous (softwood)	73,160
(b) Timber land, mainly hardwood	135
(c) Cutover land, some coniferous timber left	148,408
(d) Cutover land, some hardwood timber left	2,160
(e) Young growth,* mainly coniferous	61,806
(f) Young growth,* mainly hardwood	13,202
(g) Barren	82,959
(h) Grassland	2,334
Total	384,164

4. Estimate of Timber Damaged:

(a) Feet, board measure	15,278,000
(b) Cords (mainly pulpwood)	91,246
(c) Ties	781,685

Railway Fires.—As regards the origin of fires the outstanding feature is that almost 50 per cent. of the total number for the season was attributed to railway operation on about 5,000 miles through forest section. The worst conditions obtain on the Canadian Government Railway, where 332 fires out of a total of 549 railway fires, or 60 per cent., occurred. The Canadian Northern Railway Company was required by the Dominion Board of Railway Commissioners to place special patrolmen on some 500 miles of their lines. In addition, the Forestry Branch maintained speeder patrol on some 1,265 miles, mainly on the T. & N. O. and C. G. R.

Throughout the season inspections of fire protective appliances on locomotives on railway lines under the jurisdiction of the Board of Railway Commissioners were

*Stands averaging up to 6 inches were classified as "young growth;" above that as "timber land."

made by provincial officers authorized by the Board. Also the Temiskaming and Northern Ontario Railway Commission, which is not subject to the Board, entered into an arrangement with the Forestry Branch to permit a similar inspection of their locomotives. In all, 771 locomotives were inspected during the summer, of which 229, or 30 per cent., showed defective screens, ash pans or other appliances. This bad showing is in part explainable by the greatly increased volume of transportation coupled with a shortage of mechanic labour.

Other Causes.—Next to locomotives the commonest source is the neglected camp fire. This form of carelessness caused 154 fires, or 14 per cent. of the total. It is to be noted that 51 of the 154 were traced to the neglect of Indians in the western end of the Province.

Settlers clearing land caused 91 fires or 8 per cent. of the total. These were largely outside the area where permits are required.

Area Burned.—The total area reported burned over was 384,164 acres. Of this, around 38 per cent. was cutover land with some coniferous (softwood) timber remaining; 22 per cent. barrens; 19 per cent. coniferous timbered land; and 16 per cent. coniferous young growth (up to six inches). The fact that cutover land and young growth make up 54 per cent. of the total burned area, indicates clearly the influence of the slash and debris accompanying logging operations on the fire hazard. Forest protection can reach only a certain degree of efficiency without a consideration of the matter of brush disposal. Burned timber can usually be salvaged and is of less consequence than the oncoming crop.

Fifty per cent. of all fires did not exceed 5 acres in extent. In only 6 of the 34 fire districts did the total area burned over exceed 5,000 acres. Of the total acreage burned over, 304,677 acres were in the Kenora and Rainy River Districts, leaving 79,487 acres for the remainder of the Province. The large total in the west was caused by fires getting beyond control in the first part of the season during a prolonged dry spell. For instance, in the north-eastern part of Kenora District two fires starting from neglected Indian camp fires burned over 19,200 and 51,200 acres respectively, while another of unknown origin burned over 40,960 acres. Sparks from locomotives on the Canadian Government Railway set fires which burned over 20,160 acres in the vicinity of Millidge, 11,520 acres around Malachi and 12,800 acres north-east of Sioux Lookout. One lumbering concern caused 35 fires by using defective engines on their logging road, burning over 5,081 acres.

(5) *Permit System.*

The close season lasts from 15th April to 30th September. For the application of the regulations regarding the setting out of fire the forest region is divided into "Permit Areas" and "Exempt Areas."

The Permit Area includes those portions of the Districts of Nipissing, Temiskaming, Sudbury and Algoma, north of the C.P.R. from Mattawa to North Bay, and north of the C.N.R. from North Bay westward. Within this territory no fires may be set out without a permit from a fire ranger.

The remainder of the Province forms the Exempt Area, within which a permit is required only in the cases of those persons who have been so notified in writing by the Chief Ranger. This provides for the establishment of Permit Areas locally where conditions require it.

The season was unfavourable for cleaning up land, and only 3,486 permits to burn were issued, covering 15,186 acres, largely in Temiskaming. For a new regulation, the Forestry Branch received hearty co-operation from those concerned, and but three prosecutions were necessary.

(6) *Improvement Work.*

During the season sixty-two lookout towers were constructed; these are wooden frame towers running from thirty to ninety feet in height. In addition, twenty-six observation points were built by ladder construction on suitable trees. Along canoe routes trails were cut to all high vantage points. Owing to labour shortage and the difficulty of obtaining materials the majority of these towers are not yet connected up to telephone systems. In all only thirty miles of telephone were added this season.

The other main new improvements were:

New trails built and existing ones repaired	1,931 miles.
Rangers' cabins, 12′ x 16′	44
Boat houses	3
Hose houses	3
Motor car houses	3
Oil houses	2
Gowganda storehouse, 18′ x 20′.	
Gogama storehouse, 30′ x 50′.	
Bisco storehouse, 22′ x 32′.	
Cochrane storehouse, 40′ x 70′.	
Dams, docks, etc.	

The material for improvement work cost $7,000.00.

(7) *Equipment.*

The equipment for a force of 1,000 rangers represents a large outlay. During the year there was spent on equipment $33,000, and $5,500 additional on expendable equipment. Specially might be mentioned a 40-foot power boat for Lake of the Woods, equipped with a Gould rotary pump and 1,000 feet of 1½-inch hose. The boats on Winnipeg River and Lake Nipigon were similarly equipped with pumps and hose. Four portable fire pumps were acquired, but delivered too late in the season to be used. Five Ford auto trucks were purchased for use largely in issuing permits. Twenty-eight railway velocipedes were added to the stock. Some 65,000 fire signs were posted.

(8) *Railway Inspection Under B.R.C.*

With the exception of the T. & N. O. and C. G. Railways the lines operated in the Province are subject to the orders of the Dominion Railway Board. Twelve provincial inspectors were appointed officers of the Board to superintend the carrying out of the regulations of Order 107. These men report on all fires originating within 300 feet of the track, inspect fire appliances on locomotives, report on right-of-way conditions, and otherwise carry out the requirements of the Board.

Appended is the annual statistical summary.

STATISTICAL REPORT OF FIRES ORIGINATING WITHIN 300 FEET OF RAILWAY LINES IN ONTARIO FOR THOSE LINES SUBJECT TO THE JURISDICTION OF THE BOARD OF RAILWAY COMMISSIONERS FOR CANADA. SEASON, 1917.

	C. N. R.	G. T. R.	C. P. R.	A. C.	A. E.	Totals
(a) *Railway Fires*:						
1. Number, by causes:—						
(a) Locomotives, Class A fires	9	4	3	....	1	17
Class B fires	52	22	44	....	1	119
(b) Employees, Class A fires.	1	1	1	....	....	3
Class B fires.	8	....	5	....	1	14
(c) Total of Class A fires	10	5	4	....	1	20
Total of Class B fires	60	22	49	....	2	133
Total of railway fires	70	27	53	....	3	153
2. Areas burned :—						
(a) Young forest growth, acres	124	117	82	....	15	338
(b) Timber land	60¾	9½	40	....	....	110¼
(c) Slashing or old burn	3,306½	45½	1,692⅞	....	25	5,069⅞
(d) Other classes of land	38¾	74⅜	617¼	....	3	733⅜
(e) Total	3,530	246⅜	2,432⅛	....	43	6,251½
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth	36 00	48 00	27 00	....	10 00	121 00
(b) Standing timber	260 00	....	3 00	....	....	263 00
(c) Forest products	....	....	....	....	....	....
(d) Other property	329 65	241 10	304 00	....	....	874 75
(e) Total	625 65	289 10	334 00	....	10 00	1,258 75
(b) *Known Causes other than Railway Systems.*						
1. Number due to:—						
(a) Campers and Travellers.						
Class A fires	....	....	....	....	....	....
Class B fires	....	....	....	....	....	....
(b) Settlers, Class A fires	1	....	....	....	....	1
Class B fires	2	....	....	....	....	2
(c) Other known causes,						
Class A fires............	....	....	....	....	....	....
Class B fires.............	3	....	1	....	....	4
(d) Total of Class A fires	1	....	....	....	....	1
Total of Class B fires	5	....	1	....	....	6
Total of other known causes	6	....	1	....	....	7
2. Areas burned:						
(a) Young forest growth	....	....	....	....	....	....
(b) Timber land	....	....	....	....	....	....
(c) Slashing or old burn	503	....	2½	....	....	505½
(d) Other classes of land	¼	....	....	....	....	¼
(e) Total	503¼	....	2½	....	....	505¾
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth	....	....	....	....	....	....
(b) Standing timber	....	....	....	....	....	....
(c) Forest products	240 00	....	....	....	....	240 00
(d) Other property	....	....	....	....	....	....
(e) Total	240 00	....	....	....	....	240 00

STATISTICAL REPORT OF FIRES ORIGINATING WITHIN 300 FEET OF RAILWAY LINES IN ONTARIO, ETC.—Continued.

	C. N. R.	G. T. R.	C. P. R.	A. C.	A. E.	Totals
(c) *Fires of Unknown Origin*:						
1. Number:—						
(a) Total of Class A fires	9	1	1	....	1	12
(b) Total of Class B fires	22	2	24	1	3	52
(c) Total of all unknown fires	31	3	25	1	4	64
2. Areas burned:						
(a) Young forest growth	....	....	31	....	....	31
(b) Timber land	....	....	14	....	....	14
(c) Slashing or old burn ...	1,797	35	4,912½	¼	100	6,844¾
(d) Other classes of land	18¼	....	148½	....	10	176¾
(e) Total	1,815¼	35	5,106	¼	110	7,066½
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth	....	....	7 00	....	....	7 00
(b) Standing timber	....	....	108 00	....	....	108 00
(c) Forest products	....	37 50	....	61 50	2,383 70	2,482 70
(d) Other property	60 00	....	495 00	....	....	555 00
(e) Total	60 00	37 50	610 00	61 50	2,383 70	3,152 70
(d) *Grand Totals for all Causes*:—						
1. Number:—						
(a) Total of all Class A fires..	20	6	5	....	2	33
(b) Total of all Class B fires..	87	24	74	1	5	191
(c) Total of all fires reported.	107	30	79	1	7	224
2. Areas burned:						
(a) Young forest growth	124	117	113	....	15	369
(b) Timber land	60¾	9½	54	....	....	124¼
(c) Slashing or old burn	5,606½	80½	6,607⅞	¼	125	12,420⅛
(d) Other classes of land	57¼	74⅜	765¾	....	13	910⅜
(e) Total	5,848½	281⅜	7,540⅝	¼	153	13,823¾
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth	36 00	48 00	34 00	....	10 00	128 00
(b) Standing timber	260 00	....	111 00	....	....	371 00
(c) Forest products	240 00	37 50	....	61 50	2,383 70	2,722 70
(d) Other property	389 65	241 10	799 00	....	....	1,429 75
(e) Total	925 65	326 60	944 00	61 50	2,393 70	4,651 45

II. Reforestation.

The nurseries at the Provincial Forest Station, Norfolk County, contain at present the following plants:

White Pine transplants	150,000
Scotch Pine transplants	20,000
Scotch Pine seedlings	100,000
Jack Pine transplants	25,000
Jack Pine seedlings	50,000
White Cedar seedlings	25,000
Red Pine seedlings	25,000
Miscellaneous conifers	10,000
Black Walnut seedlings	30,000
Butternut seedlings	10,000
Sugar Maple seedlings	75,000
White Maple seedlings	50,000
Red Maple seedlings	5,000
Manitoba Maple seedlings	2,000
White Ash seedlings	10,000
American Elm seedlings	5,000
Tulip or Whitewood	5,500
Carolina Poplar cuttings	25,000
Miscellaneous Hardwoods	8,000
Total	630,500

The production of planting material in the nurseries this past season is low owing to the difficulty of procuring suitable seed. Scotch Pine, one of our best trees for waste land planting, is grown largely in Europe, whence we obtain our seed. At present it is impossible to obtain reliable seed of this tree. The native Red Pine is an important tree in connection with this work and we have not had a crop of seed for two years.

The experimental plantations made at this Station during the past years are showing splendid growth. The earliest plantation of pine, made in 1909 on a blow sand ridge, is now twelve to fifteen feet in height and is of great interest to visitors.

During this season we shipped to other parts of the Province about 100,000 plants. Applications for planting material are not coming in as they did previous to the war, and I presume this is largely due to lack of labour.

III. Tree Diseases.

This has reference largely to the White Pine Blister Rust.

During the season twenty inspectors were engaged in scouting for the disease, and eradicating the currant and gooseberry hosts. This work was carried on with the co-operative supervision of the Dominion Plant Pathologist at St. Catharines, Mr. W. A. McCubbin, to whom we are greatly indebted for this assistance.

On the opening of the fall term the public schools of old Ontario were circularized with a description of the disease and requested to send in suspected currant leaves. Some 4,500 teachers were reached, of whom 1,450 sent in material. This method showed the disease to be much more widely spread than had been thought. The Forestry Branch takes this occasion to express its sincere thanks to the county inspectors, teachers and pupils for their hearty co-operation.

The disease has now been found in thirty-eight counties. So far as known, the northern limit to which it has progressed is a line through northern Simcoe and Ontario, southern Haliburton, southern Peterborough and eastward, and all the peninsula east of Perth town, with an outlying infection at Petawawa. The situa-

tion is accordingly very serious, as it is probable the disease cannot now be stamped out. It would appear that local control, by eradication along the northern limit, is the only practicable measure left.

The disease exists in the following counties: Brant, Bruce, Carleton, Dufferin, Dundas, Durham, Elgin, Frontenac, Glengarry, Grenville, Grey, Haldimand, Haliburton, Halton, Huron, Kent, Lanark, Leeds, Lennox and Addington, Lincoln, Middlesex, Norfolk, Northumberland, Ontario, Oxford, Peel, Perth, Peterborough, Prescott, Renfrew, Russell, Simcoe, Victoria, Waterloo, Welland, Wellington, Wentworth, York.

The Provincial Forester attended a White Pine Blister Rust conference at Pittsburg on the 12th and 13th of November. This conference was called in order to bring together the results of investigations which have been carried on in the United States and Canada.

The reports presented at this meeting show that the disease is present in all the north-eastern States, in Quebec, in Ontario, and as far west as Minnesota; that in some states it is so widespread that its entire eradication is hopeless.

The general conclusion reached at the Pittsburg meeting was that this disease cannot be eradicated, but that white pine can still be grown where local control measures are adopted. This was the opinion expressed by the leading plant pathologists from both countries.

Following the Pittsburg conference a meeting was called at Ottawa of representatives of the Dominion Department of Agriculture, Department of the Interior, the Conservation Commission, Ontario Agricultural College, Departments of Lands and Forests of Quebec and Ontario, and the Lumbermen's Association. After a thorough consideration of the whole situation in Canada the following conclusions and recommendations were arrived at:

1. That it is in the opinion of this meeting at present not feasible, from the practical viewpoint, to eradicate the disease from the heavily infected white pine region in Eastern Canada. This meeting is, nevertheless, of the opinion that much may be done to control or retard the spread of this disease to areas where it is not already found, and to minimize its injurious effects where its occurrence is apparently threatening the white pine forest of a given district.

2. That in the opinion of this meeting scouting for the purpose of finding whether the disease exists in districts not yet examined should be continued.

Inspections have been carried out thoroughly in the southern part of the Province of Ontario and it is considered that further systematic inspections in this district are unnecessary, but inspections should be continued and extended into Northern Ontario, especially between the southern districts and the main white pine areas. Scouting should be continued in the Provinces of Quebec and New Brunswick and should be extended to Nova Scotia and British Columbia.

3. That there are cases of occurrence of the rust on domestic Ribes, especially in isolated positions, where it would be advisable to take steps for the eradication of the domestic Ribes, and in such cases that action should be taken.

An instance of the occurrence referred to is found in the isolated area of infection found at Petawawa, in the Province of Ontario, and while the eradication of the disease is no longer possible on large areas, experience in both Canada and the United States indicates that small centres of infection can be eradicated.

4. Restrictions to be placed on the movement of Ribes and Grossularia (currants and gooseberries) from Ontario nurseries north of a general line to be definitely located later, but which may be somewhere about the Grand Trunk Railway, Parry Sound line, and that similar action be taken in the Province of Quebec.

The plants mentioned are secondary hosts of the White Pine Blister Rust and are, undoubtedly, one of the channels by which the disease is distributed. In order to prevent the development of further areas of infection in the main white pine districts it is considered necessary to prevent the distribution of such stock through such districts.

5. That restrictions be placed on the movement of Ribes and Grossularia from nurseries in the Provinces of Ontario and Quebec to other provinces.

The distribution of such stock from nurseries in affected districts in the Provinces of Ontario and Quebec might spread the disease rapidly and nullify efforts for its control made by other means. This is specially necessary to protect the white pines of the Pacific coast. While the eastern white pine area is by far the most important on the continent a number of five-needle white pines, which are known to be susceptible to the disease, are present on the Pacific coast, covering areas of such magnitude that their freedom from the disease would be a matter of extreme importance. There is no record as yet of the presence of the disease in British Columbia or the western states, and it is considered by foresters and pathologists as extremely desirable that the disease should be kept from these areas. The measures necessary to attain this end would involve a quarantine to prevent the shipment of nursery pines and currants from the eastern infected districts into areas not yet reached by the rust.

6. The only hope of growing white pine in the future depends on our ability to keep it free from this disease. It is well recognized that in order to do this all plants of the genera Ribes and Grossularia (currants and gooseberries) must be removed from and around the pine area. It is impossible with our present knowledge to state the exact distance at which pines may be safely grown and a great deal of observation and experiment will be necessary in order to ascertain this distance. Control areas for this purpose have already been established in several of the New England states, and it is highly advisable that similar control areas should be established under Canadian conditions. If these control areas are begun immediately we shall have obtained in a few years definite information on the most critical and vital point in regard to this disease. Unless definite information of this kind can be secured shortly the encouragement of pine growing or the establishment of new pine areas will be a very uncertain project. There is still needed a great deal of investigation which can only be carried out by the plant pathologist. Some work has already been done in Canada along this line, but there are so many questions in regard to the disease which need immediate investigation that it is felt that special attention should be given to such investigation for a number of years to come.

7. The problem in its extent no longer concerns one department or government alone. It is no longer entirely a plant pathological question, but necessitates co-operative action between departments and governments, and with foresters, lumbermen, nurserymen, fruit growers, and other interests. Unless all combine in the support of necessary measures it will be impossible to carry out the work successfully as it cannot be done by government action alone.

8. That in order to ensure full co-operation and concentration of effort it is considered advisable that a commission, having executive authority to direct the necessary work to control the White Pine Blister Rust in Canada, should be formed and duly empowered by the governments and associations concerned, such commission to consist of representatives of the following bodies:

Dominion Department of Agriculture; Dominion Department of Interior; Department of Lands, Forests and Mines, Ontario; Department of Lands and Forests, Quebec: Department of Lands and Forests, New Brunswick; Canadian Lumbermen's Association; Canadian Nurserymen's Association.

9. That the moneys necessary to carry out the work should be appropriated by the governments concerned and placed at the disposal of the Commission.

10. That the total annual amount necessary to carry out this work will be about $100,000.

I have the honour to be, Sir,

Your obedient servant,

E. J. ZAVITZ,

Provincial Forester.

Appendix No. 35.

RETURNED SOLDIERS' AND SAILORS' LAND SETTLEMENT SCHEME.

Considerable progress has been made in connection with the above plan of settlement during the past year. A temporary training school, accommodating about thirty men was constructed at Monteith, and a much larger permanent building is nearing completion. At Kapuskasing, in the Township of O'Brien, substantial buildings have been erected for the accommodation of the first colony of returned men. The chief buildings consist of nineteen dwellings, fronting on Kapuskasing River, occupied by some of the married men and their families; a large dwelling and office for the superintendent and clerk; a dormitory accommodating fifty men, with kitchen, dining-room and living-room attached; a modern school house which will be in use in January of 1918; a freight shed; a store and several other buildings of a minor class. Some forty-one men are now at Kapuskasing, to be joined at the first of the year by twenty-four of their comrades now at Monteith.

The men in the first place cleared a site for the buildings, and in addition some thirty acres on the Provincial Government farm, which will be maintained at the Colony. This clearing will be placed in crop in the spring of 1918. Their labours are now being directed to the clearing of 10 acres on the front of each 100-acre lot. When sufficient 10-acre clearings have been made to accommodate each member of the party one lot will be allowed to each man.

The men are paid from the time they enter the training school until they go on their respective lots; the rate of pay varies from $65 to $84.10 per month, according to the number of their dependents.

The men seem satisfied with their prospects for the future, and undoubtedly this plan of settlement will overcome a great many of the difficulties pertaining to settlement in any new country. Over 500 applications are on file.

Major T. L. Kennedy, of Dixie, also a returned soldier, is in charge of the Kapuskasing Colony.

ALBERT GRIGG,

Deputy Minister.

REPORT

OF THE

Minister of Lands, Forests and Mines

OF THE

PROVINCE OF ONTARIO

For the Year Ending 31st October

1918

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

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1919

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Stand of Second-Growth White Pine.

Report of the Minister of Lands, Forests and Mines of the Province of Ontario.

For the Year Ending 31st October, 1918.

To His Honour the Lieutenant-Governor of the Province of Ontario.

MAY IT PLEASE YOUR HONOUR:

I have the honour to submit for the information of your Honour and the Legislative Assembly a report for the fiscal year ending 31st October, 1918, of the management of the Crown Lands of the Province.

CLERGY LANDS.

The collection on account of Clergy Lands was $355.40. No land was disposed of during the year. (See Appendix No. 4, page 19.)

COMMON SCHOOL LANDS.

The collection on account of former sales was $7,341.97. (See Appendix No. 4, page 19.)

GRAMMAR SCHOOL LANDS.

The area of these lands sold during the year was 47 acres for $58.75. The collection on account of these and former sales was $288.00. (See Appendix No. 4, page 19.)

UNIVERSITY LANDS.

The area of these lands sold during the year was 1,288.25 acres for $786.01. The collection on account of these and former sales was $1,417.31. (See Appendix No. 4, page 19.)

CROWN LANDS.

There was sold during the year for agricultural and town site areas 51,401.22 acres for $39,775.01. The collection on account of these and former sales was $50,253.53. There was sold for mining purposes 12,125.64 acres for $32,180.67. There was collected on account of these and former sales $33,535.58.

There was leased for mining purposes 3,119.46 acres for $3,040.04. There was collected on account of these leases and those of former years $14,009.15. There was leased of Crown lands an area of 35,424.36 acres for $3,535.45. There was collected on account of these and the leases of former years $68,700.58.

The total area of Crown lands disposed of by sale and lease during the year was 103,701.59 acres for a value of $80,345.43, as compared with 165,628.06 acres sold and leased in 1917 for $140,948.30. The total collection on account of the sales, leases, etc., was $176,966.17. (See Appendix No. 3, page 18.)

Sales.

From Appendix No. 15 one will get a detailed statement of all land sales and patents other than those appearing in Free Grant territory. As was expected and predicted last year the number of sales made and the number of purchasers have very perceptibly dropped. For the fiscal year ending 31st October, 1918, practically only one half of the previous year's settlement was accomplished. The source of supply throughout the war was extremely limited, Ontario being the only field in effect upon which to draw, and the war with its various activities tended most acutely to render it almost impossible to secure the needed settlers. Numbers of the hardy settlers of the North at the call to arms dropped the plough and went forth to their duty, and some of the patented lands thus left were no doubt requisitioned by friends and others who might otherwise seek their own homesteads from the Crown. Over 600 settlers on Crown Lands in the North, to the knowledge of the Department, enlisted in the Canadian Expeditionary Forces, and, while numbers of these paid the supreme sacrifice, it is confidently predicted that the others, who seemed satisfied with their lot in their pioneer homes in Ontario will in time return to their farms, which have been retained for them. It is not unreasonable to expect that each will induce his friends to try their lot in the clay belt of Ontario, where health and plenty wait the willing worker.

As immigration conditions are but problematical it is impossible to adequately forecast an immediate return to a normal improvement in land purchases.

Free Grants.

As predicted in the report for last year there is a notable reduction in the number of Free Grant locations effected throughout the fiscal year ending October 31st, 1918; only 372 Free Grant settlers acquired free homesteads for an area of 48,687 acres, whereas during the previous year over 600 secured locations. An additional area of 4,570 acres was taken by 110 locatees, who had the privilege of purchasing an adjoining farm for grazing or agricultural purposes.

The number permitted to assign their interests in locations to parties entitled and prepared to continue settlement totalled 166, as against 217 for the year 1917. Patents to the number of 406 were issued, slightly less than for the corresponding period immediately preceding.

Conditions imposed by the war and the general decline for Free Grant, as for other class of farm land, have materially contributed towards the declining figures in Free Grant transactions. Many of the townships in Free Grant territory appearing in Appendix No. 14 have been opened for years and practically all the choice land therein has been sought, but so long as an occasional lot may be left and desired the township remains in the market and attached to a regular agent. No new townships were opened during the year under the Free Grant Section of the Public Lands Act as the necessity did not exist, and only the future can with a degree of certainty say to what extent the demand for Free Homestead Land may grow, but at present the outlook for transcending the figures of but a few years ago is not of the brightest.

Under the Returned Soldiers' and Sailors' Land Settlement Act, 1917, free locations along with other privileges were given to 53 returned men, 49 in the Township of O'Brien for 5,018 acres, and 4 in the Township of Owens for 477 acres.

A list of the islands disposed of for Summer Resort purposes in Free Grant territory, may be found in Appendix No. 14.

Military Grants.

Under the Veteran Land Act I. Edward VII., cap. 6, and amendments thereto have been issued 13,998 certificates, and although the time for receiving applications for these grants expired on the 30th September, 1908, there are still letters being received from men who were entitled to this grant, but claim that they have only now become aware of the fact. The applications therefore could not be accepted and no forms of applications have been sent out.

During the past year there have been located 23 of these certificates covering 3,678 acres in the townships open for veterans, making in all a total of 8,284 certificates thus located.

In eleven cases the certificates have been surrendered and applied in payment of lands purchased from the Crown, covering in all 1,760 acres making a total of 785 that have thus been applied.

There were three certificates surrendered to the Crown for the $50.00 commutation money, making a total of 3,260 certificates surrendered in this manner.

During the year there have been issued 115 patents for lands located by veterans, and in all 7,337 have thus been disposed of.

The total number of certificates that have therefore been disposed of is 12,329 leaving 1,669 that are still outstanding.

During the year 15 veteran locations, covering 2,392 acres, were cancelled for the non-performance of the settlement duties to which they became subject on account of being assigned before patent was issued.

Under the Act I., Edward VII., cap. 6, and amendments thereto covering these grants it is necessary for all locatees of the lands granted under this Act to apply for their patents for such lands before ten years have expired from date of location. If this application for patent is not made within ten years then the land comes under the settlement regulations, and unless the settlement duties are proceeded with, the locations are liable to cancellation. Previous to the expiration of the ten years after location, the Department has sent a notice to each veteran, who should apply for his patent stating this fact, and in this manner have saved many of the locations from becoming subject to the settlement duties. See Appendix No. 11.

Patents, Leases, Licenses, etc.

In consequence of the growing diminution during war period of land seekers and land tillers in the northern sections, fewer engrossed instruments were issued during 1918 than the previous year by over four hundred, some 1,778 having been prepared last year, as against only 1,351 for this year. These were made up of 741 settlers' patents, 337 mining and 115 veteran grants; the remaining numbers consisted of Crown Leases to the number of 20 covering a variety of subjects, including water powers, sand and gravel, ranching, etc. Of the last class eight were issued, an increase of seven over the preceding period, probably the most important ranch lease having been issued for a three thousand acre block in the Peterborough district, in Cavendish Township, where already some 350 head of cattle are being regularly maintained; inquiries in respect of the grazing possibilities and the opportunities offered are being constantly made, and the hope is expressed that in the reconstruction period, when the problems of employment and production with their concomitant economic interests are being solved, the vast acres of Ontario waste lands, now unproductive, will not be overlooked as a means to an important end.

Equally important with the growing of grain is the raising of cattle and sheep, and already it has been demonstrated in parts of the hitherto so-called useless areas of Old Ontario that the application of a little scientific knowledge and practical energy has resulted in successful cattle and sheep enterprises. Wherever and whenever Crown Lands are desired for such purposes and *bona fide* dealers make application an officer of the Department, at its expense, makes a cruise, preferably in company with the applicant, reports fully as to the wisdom of the selection, and makes any suggestion or recommendation that may be to the mutual advantage of all interested. The annual rental for ranching leases is only five cents an acre and the stocking requirements are reasonable, every effort being made to keep them from appearing prohibitive.

Approximately the same number of Licenses of Occupation issued for the year ending October 31st, 1918, some fifty, as the previous year. These included mining, lumbering, custom house sites, game and fisheries, sugar making, pipe lines, rights of ways, settlers' rights, water powers, tile manufacture, and a variety of other subjects. Rights to remove sand and gravel under certain conditions were granted to eighteen different individuals or concerns by special leases.

Sixty-eight mining leases were issued and also two leases for islands in Lake Timagami.

Under Appendix No. 8 may be found a detailed statement of all instruments prepared and issued during the fiscal year.

Financial Assistance to Settlers.

Since August 12th, 1916, 1,839 applications for loans have been dealt with by the Settlers' Loan Commissioner—1,306 loans totalling $419,286.00 have been made.

Among the benefits derived in this connection might be mentioned, increased acreage placed under cultivation, larger holdings of live stock, and improved buildings.

Payments of accrued interest and maturing principal have been remarkably prompt.

A loan of $12,000.00 was made to the Sudbury Co-operative Creamery Co. during the fiscal year just closed. Other loans to creameries, grist mills and cheese factories will doubtless be required.

The Mining Industry.

The mining industry of Ontario was greatly affected by the war. Nickel and copper are prime requisites for modern warfare, and the production of these metals in 1918 was on a larger scale than ever before. Silver was needed in huge quantities for the payment of troops, as well as to purchase the exportable products of silver-using countries, which owing to war conditions could not be paid for by exchange of goods. These metals have ruled at high prices, and the mining districts of Sudbury and Cobalt had a prosperous year.

Gold being the basis of international finance, was also in great demand, but as the increased cost of production, because of the fixed price of gold, could not be shifted to the consumer as in the case of the other metals, this branch of the industry was less active than it would otherwise have been. Notwithstanding this, however, the production for 1918 was slightly greater than that of the previous year. The gold camps of Porcupine and Kirkland Lake will undoubtedly, when normal prices for labour and supplies are restored, resume their former activity and undergo rapid development, and the newer areas, such as Boston Creek, Matachewan, etc., will be vigorously exploited. The growth of the mining

industry will greatly assist in the settlement of the agricultural districts of northern Ontario, since it provides a ready market for all kinds of farm products, attracts population, and furnishes employment for labour. The mining areas so far developed are, for the most part, near or within the limits of the agricultural districts, thus bringing producer and consumer into proximity and lessening transportation charges.

The mattes produced at the Sudbury smelters in 1918 contained about 44,700 tons of nickel as compared with 41,887 in 1917, and the value was say, $26,800,000 as against $20,493,500. The copper contents of the mattes was about 23,000 tons, valued at $8,500,000, compared with 21,197 tons in 1917 worth $7,842,290. The producing companies were: The International Nickel Company of Canada—a re-organization of the Canadian Copper Company and subsidiary concerns—and The Mond Nickel Company. The Alexo mine in Dundonald also contributed 10,000 or 12,000 tons of ore, which was smelted by the Mond Company at Coniston. The International Nickel Company's refinery at Port Colborne was completed during the year and put into successful operation, and has a refining capacity of 10,000 tons of nickel and a corresponding quantity of copper per annum. The British America Nickel Corporation has been steadily developing the Murray mine, and is constructing a smelter and refinery. Owing to the difficulty of obtaining a suitable supply of electric power at the mine, the latter is being erected at Hull, Quebec.

The production of silver amounted to about 17,500,000 ounces, worth $16,675,800 as against 19,479,692 ounces in 1917, worth $16,183,208. In value, last year's silver production was only exceeded in the history of the Cobalt camp by that of 1912, when it was $17,408,935. The total yield of silver from these mines up to the end of 1918, has fallen little short of 300,000,000 ounces. The leading producers were the Nipissing, Mining Corporation, Kerr Lake, O'Brien, Coniagas, and McKinley-Darragh-Savage. The high price of silver not only stimulated production, but also exploration, and a number of prospects within the boundaries, or at the verge of the territory of proven value have been and continue under development.

Iron ore was produced to the extent of 154,243 tons during the first nine months of the year. With the exception of small shipments from a couple of mines in Eastern Ontario, this all came from the Magpie and Moose Mountain mines. The total quantity of pig iron produced by the blast furnaces of the Province was about 890,000 tons, valued at say $20,000,000. To produce this, about 1,500,000 tons of iron ore were required, nearly all of which was imported from the United States.

Many minor minerals are raised in Ontario which form the bases of important and expanding industries. Iron pyrites, for example, which was mined chiefly in northwestern but also in eastern Ontario, was in large demand by the United States' makers of sulphuric acid, of which very large quantities were required for the manufacture of explosives. Imports of elemental sulphur from Sicily were entirely cut off by the war, and the deposits in Louisiana and Texas were not equal to supplying the demand for sulphur, consequently the pyrite deposits of Ontario were drawn on during the year for large shipments. It is estimated that about one-third of the total pyrite consumed by the United States during 1918 came from Ontario.

Cessation of the war will probably lead to a lessened demand for nickel, copper, pyrite, and perhaps some of the other mineral products of the Province, but as peaceful industry is again re-organized and re-established, it is quite probable that the requirements for manufacturing and trade will ere long restore the demand to at least its former level.

Collections.

The total revenue of the Department from all sources was $2,964,161.76. Of this, $50,253.53 came from agricultural lands and town sites; mining lands, $33,535.58; mining and Crown leases, $83,774.38; miners' licenses, permits and recording fees, $52,271.86; supplementary revenue tax, $919,208.80. From woods and forests the revenue was $1,756,085.25, made up of the following items, bonus, $679,304.17; timber dues, $795,004.08; ground rent, $87,263.93; transfer fees, $4,740.00; fire protection charge, $189,773.07. (See Appendix No. 4, page 19.)

Disbursements.

The total expenditure of the Department for ordinary service was $965,615.73. Some of the principal items were: Crown Land agents' salaries and disbursements, $18,202.13; homestead inspectors, $14,978.75; Crown timber agents, $31,088.07; forest ranging and estimation of timber, $125,474.84; fire ranging, $394,784.90; forest reserves, fire ranging, etc., Temagami reserve, $48,009.52; Mississaga reserve, $24,454.34; Nipigon reserve, $23,457.35; Eastern reserve, $3,424.13; Sibley reserve, $100.00; mines and mining, $60,802.72; mining recorders, $23,630.95; surveys, $40,827.29; investigation of tree diseases, $5,410.53; contingencies, land and forests, $39,947.14; Bureau of Mines, $12,653.85; forestry, $3,221.80; colonization, $1,072.38.

A further sum of $50,907.28 was expended under the direction of the Department, distributed as follows: Algonquin Park, $29,866.03; Quetico Provincial Park, $9,424.20; Veteran's Commutation, $150.00; Royal Nickel Commission, $10,182.05; legal investigations, $1,285.00.

The sum of $55,027.49 was disbursed under the provisions of the Bounty Act, Edward VII, Cap. 14. (See Appendices Nos. 6 and 7.)

Woods and Forests.

The accrued revenue from Woods and Forests for the year ending October 31st, 1918, amounted to $1,635,684.43 which exceeded that of the previous year by $139,620.98.

The revenue collected during same period totalled $1,756,085.25, or $60,382.17 in excess of amount collected during year ending October 31st, 1917.

The production of pine timber, saw log and dimension timber—during season of 1917-18 while very much less than during the seasons of 1914-15 and 1915-16 exceeded that for 1916-17 by over fifteen million feet board measure, a satisfactory increase in view of the prevailing labour conditions. With labour conditions rapidly improving and with increased demand for lumber both at home and abroad it is confidently expected that the production during the coming season will show a still greater increase.

In timber other than pine there was a falling off in production of nearly eight million feet board measure.

Over half a million more railway ties were taken out last season, the figures being 2,094,099, as against 1,544,826 for 1916-17.

Three hundred and thirty-eight thousand, five hundred and sixty-three cords of pulpwood were taken off Crown Lands an increase of 114,892 cords over the previous season.

The sale of the Kapuskasing Pulp and Timber Limit to which reference was made in 1917 report has since been carried out.

Lands Under License.

The area under license at the close of the fiscal year was 16,888 square miles which was 574¼ square miles greater than for previous year.

Summary of Revenue from Woods and Forests.

Timber dues	$795,004 08
Bonus	679,304 17
Ground rent	87,263 93
Transfer fee	4,740 00
Fire protection	189,773 07
	$1,756,085 25

Culler's Examination.

Two examinations were held during the year, one at North Bay and one at Kenora. Two candidates succeeded in passing the examination and were duly granted certificates authorizing them to act as Cullers. For names of Cullers who passed at these examinations, see page 63, Appendix 12. For complete list of Licensed Cullers see Minister's Report for 1917.

Fire Ranging.

As pointed out in the Annual Report for 1917, some decided changes were made in methods of forest protection in conformance with the legislation passed during the session of 1917.

During the season of 1917-18, 9,590 permits for the burning of slash by settlers were issued as against 3,486 permits for the previous season. The acreage covered by these permits for the present season amounted to 39,683 as against 15,186 acres for the previous season. The permits are issued by members of the fire ranging staff, and, generally speaking, the settlers co-operate heartily and appear to appreciate the wisdom of the new regulations.

There were five prosecutions for infringements of the regulations under the Forest Fires Prevention Act, and convictions were registered in all cases.

The area protected was re-grouped, the new arrangement providing for 32 districts instead of 34, each district being in charge of a chief ranger as formerly. The number of territorial inspectors was increased to four instead of three as formerly, their headquarters being at Cochrane, Nipigon, Sudbury and Parry Sound, respectively. The general field work was supervised by a Provincial Superintendent with headquarters at Sudbury.

The maximum number of rangers and supervising officers was 1,190.

Improved methods were adopted to enable a closer check to be kept on the work of all men engaged in forest protection.

Forest Fires.

The weather, generally speaking, was favourable for forest protection. As in the case of last season, the railways furnished the most fruitful cause of fires. Over 46 per cent. of the fires reported were of railway origin. Approximately 10 per cent. of the fires reported were caused by careless campers. Eight per cent. of the total number of fires appear to have been caused by the land-clearing operations of settlers.

Improvement Work.

During the season, twelve lookout towers were constructed. Three hundred and four miles of new trails were cut out, and some improvements were made in the telephone systems. Fifty-eight rangers' cabins were constructed, also two boat houses, one motor car house and one garage. Numerous other improvements of a minor nature were made.

Equipment.

Additions were made to the equipment as follows: 5 Ford auto trucks; 5 portable fire pumps; 5 large boats; 3 railway motor cars; 36 railway velocipedes; 100 tents and 65 canoes. Fire signs were very widely distributed and a large number of calendars were also issued for educational effect. A booklet of instructions for all men in the field was printed and a copy furnished to each employee.

Forestry.

The work of the Provincial Forestry Station in Norfolk was continued. A glance at the detailed report of the Forestry Branch will show the magnitude of the work which is being carried on at this point.

Tree Diseases.

Very important work is being done in connection with the investigation of tree diseases throughout the Province. Valuable investigations were conducted by Dr. J. H. Faull, and his report will also be found included in the general report of the Forestry Branch.

A complete summary of the work of the Forestry Branch will be found in Appendix No. 31, page 142.)

Crown Surveys.

The following surveys of Crown Lands have been carried on during the year:—

Islands in the Georgian Bay and Lake Huron, in the districts of Manitoulin and Parry Sound, which completes the survey of islands in Lake Huron and Georgian Bay under the control of the Province.

Township of Kapuskasing, district of Algoma.

Township of O'Brien, district of Algoma.

Township of Idington, district of Algoma.

Township of Cumming, district of Algoma.

Township of Owens, district of Timiskaming.

Township of Williamson, district of Timiskaming.

The last five mentioned townships were surveyed into one hundred-acre lots, for the purpose of returned Soldiers' and Sailors' Land Settlement.

Traverse of the Namakan River in the district of Rainy River.

Survey of Lower Shebandowan Lake, in the district of Thunder Bay.

Survey of the boundaries of the Black Sturgeon River Pulp and Timber Limit, in the district of Thunder Bay.

Survey of Base and Meridian Lines in the districts of Thunder Bay and Timiskaming.

For Crown Surveys see Appendices Nos. 16 and 17, page 76.

Municipal Surveys.

Four municipalities petitioned for special surveys during the year and instructions were given authorizing the same to be made.

Three municipal surveys for which instructions were previously given were confirmed during the year under R.S.O. 1914, Cap. 166, Sections 13 and 14, such surveys being final and conclusive, including a survey of part of the Toronto and Hamilton Highway, between the westerly limit of the Town of Oakville and the City of Hamilton.

Particulars relating to these will be found in Appendices Nos. 18 and 19, pages Nos. 77 and 78.

Maps.

New editions of the maps comprising the districts in Northern Ontario have been issued during the year and are revised from time to time as new surveys are made and additional information procured.

Returned Soldiers and Sailors—Land Settlement.

Work has been continued at the Kapuskasing Colony for Returned Soldiers and Sailors during the past year. Numbers of soldier settlers are now residing on their locations and are directing their energies towards land clearing, cutting pulpwood, etc.

A full report as to the activities at the Colony will be found in Appendix No. 32, page 160.

G. H. Ferguson,

Minister.

Department of Lands, Forests and Mines,
Toronto, October 31st, 1918.

Ontario Government Creamery,, New Liskeard.

APPENDICES

Appendix No. 1.

Return of Officers and Clerks of the Department of Lands, Forests and Mines for the year ending October 31st, 1918.

Branch.	Name.	Designation.	When Appointed.	Salary per annum.	Remarks.
	Hon. G. H. Ferguson	Minister	1914, Dec. 22	$6,000 00	
	Albert Grigg	Deputy Minister	1915, Oct. 13	4,200 00	
	C. C. Hele	Minister's Secretary and Secretary to Department	1912, Jan. 23	2,500 00	
	H. M. Robbins	Assistant to Deputy Minister	1918, Apr. 25	2,200 00	
	J. Farrington	Clerk	1916, Jan. 6	1,300 00	
	A. G. Thompson	do	1909, Mar. 24	1,000 00	
	W. A. Fleming	Stenographer	1915, Feb. 16	850 00	
Lands Branch...	J. J. Murphy	Advisory Chief Clerk	1872, May 1	2,300 00	
	W. C. Cain	Chief Clerk	1903, Mar. 6	2,100 00	
	H. E. Johnston	Clerk of Military Grants	1907, Mar. 13	1,850 00	
	W. R. Ledger	Clerk of Sales	1894, Feb. 5	1,700 00	
	S. Draper	Clerk of Free Grants	1903, Jan. 1	1,600 00	
	S. A. Platt	Clerk	1907, Mar. 13	1,250 00	
	F. Lucas	do	1909, Mar. 24	1,300 00	
	J. E. Drinkwater	do	1916, May 3	1,300 00	
	C. S. Jones	Clerk of Patents	1890, May 22	2,150 00	
	W. S. Sutherland	Engrossing Clerk	1902, Jan. 13	1,550 00	
	C. E. Burns	Reference Clerk	1900, April 9	1,650 00	
	W. Carrell	Engrossing Clerk	1904, Jan. 15	1,450 00	
	A. E. Robillard	do do	1894, May 8	1,200 00	
	A. E. Roe	Clerk of Registers	1909, Mar. 24	1,450 00	
	S. Ross	Stenographer	1917, Oct. 30	900 00	
	M. Bengough	do	1896, Oct. 23	900 00	
	J. C. Oram	do	1907, Jan. 16	900 00	Resigned August 6, 1918.
	E. F. O'Neil	do	1904, Nov. 9	900 00	
	E. G. Halliday	do	1909, Mar. 24	900 00	
	B. M. Benson	do	1911, Mar. 3	850 00	
	E. Hills	do	1916, May 3	850 00	
	E. Deadey	do	1918, Oct. 16	800 00	
	L. V. Rorke	Director	1909, May, 5	3,500 00	
	J. Hutcheon	Surveyor and Draughtsman	1913, May 20	2,500 00	
	W. F. Lewis	Clerk	1872, Feb. 5	1,400 00	

Surveys	D. G. Boyd	Draughtsman	1897, Sept. 27	1,850 00
	E. M. Jarvis	Clerk	1904, Oct. 19	1,600 00
	J. B. Proctor	do	1897, Jan. 15	1,400 00
	B. Rushford	Draughtsman	1912, Oct. 5	1,200 00
	F. E. Blanchet	do	1907, Mar. 13	1,300 00
	A. Leaman	do	1909, Mar. 24	1,300 00
	H. Treeby	do	1904, Jan. 13	1,450 00
	J. Work	do	1911, Mar. 3	1,450 00
	H. M. Kirkland	Stenographer	1904, Nov. 23	900 00
	C. O'Connor	do	1911, Mar. 3	800 00
	E. C. Armer	do	1911, Mar. 3	800 00
Woods and Forests	J. A. G. Crozier	Advisory Chief Clerk	1867, Dec. 1	2,300 00
	J. Houser	Chief Clerk	1907, Mar. 13	2,000 00
	J. B. Cook	Clerk	1898, Aug. 1	1,950 00
	H. Gillard	do	1900, April 9	1,700 00
	F. J. Niven	do	1903, Mar. 6	1,650 00
	W. F. Trivett	do	1904, Jan. 13	1,500 00
	R. H. Hodgson	do	1904, Nov. 23	1,400 00
	A. H. O'Neil	do	1909, Mar. 24	1,200 00
	G. W. Harris	do	1909, Mar. 24	1,200 00
	N. L. Rogers	do	1911, Nov. 2	1,300 00
	S. D. Meeking	do	1910, May 12	1,100 00
	E. H. Squire	do	1916, April 6	1,100 00
	E. H. Telfer	do	1916, April 6	1,000 00
	C. Rowland	Stenographer	1915, Mar. 23	900 00
	M. E. Bliss	do	1909, Sept. 1	900 00
	H. Canton	do	1915, Oct. 9	800 00
Accounts	D. G. Ross	Accountant	1861, April 15	3,000 00
	H. M. Lount	Clerk	1904, Jan. 13	1,750 00
	C. J. Clarke	do	1907, Mar. 13	1,350 00
	R. Gordon	do	1913, April 30	1,200 00
	W. A. Burritt	do	1908, April 8	1,350 00
	C. Bowland	Clerk and Stenographer	1911, Mar. 3	900 00
Forestry	E. J. Zavitz	Provincial Forester	1912, Nov. 7	3,500 00
	J. H. White	Assistant Provincial Forester	1917, April 1	3,000 00
	F. S. Newman	Forester	1913, Sept. 23	1,800 00
	J. Bald	Stenographer	1914, Oct. 28	800 00

Appendix No. 1.—Concluded.

Return of Officers and Clerks of the Department of Lands, Forests and Mines for the year ending October 31st, 1918.

Branch.	Name.	Designation.	When Appointed.	Salary per annum.	Remarks.
Colonization	H. A. Macdonell	Director	1910, Feb. 16	2,450 00	
	J. Argue	Clerk	1905, April 1	1,700 00	
	R. A. Jones	do	1909, April 1	1,600 00	
	C. W. Garthwaite	do	1910, Nov. 1	1,300 00	
	H. Tutt	do	1911, Mar 30	1,200 00	Transferred to Public Works, March 16, 1918.
	S. O. Dennis	Clerk and Stenographer	1910, Nov. 1	900 00	
	R. Duggan	Stenographer	1910, Feb. 1	900 00	
	F. R. Dunlop	do	1913, Jan. 1	825 00	
	B. McDonald	do	1910, Nov. 1	900 00	
Records Branch	S. K. Burdin	Chief Clerk	1916, April 6	2,400 00	
	C. Dies	Clerk	1907, Mar. 13	1,450 00	
	A. P. Saunders	do	1913, April 30	1,200 00	
	C. W. St. John	do	1910, April 14	1,200 00	
	A. Ferguson	do	1916, April 6	1,300 00	
	W. B. Baines	do	1912, Oct. 5	1,150 00	
	F. Samuels	do	1909, Mar. 24	1,125 00	
	N. Mathewson	do	1918, April 25	1,000 00	
	H. Brophy	Mailing Clerk	1898, Oct. 1	1,100 00	
Bureau of Mines	T. W. Gibson	Deputy Minister	1891, June 19	4,200 00	
	R. D. Fisher	Secretary	1907, Mar. 13	1,700 00	
	D. H. Barr	Clerk	1907, Mar. 13	1,450 00	
	F. L. Godson	do	1915, June 18	1,100 00	
	W. Lemoine	do	1908, April 8	1,350 00	
	Anne Moffatt	do	1901, Mar. 1	1,300 00	
	A. G. Scovell	do	1909, Mar. 24	1,350 00	
	J. L. McNaughton	Clerk and Stenographer	1909, Mar. 24	900 00	
	H. W. Batchelor	Stenographer	1911, Mar. 19	850 00	
	M. Baptie	Clerk and Stenographer	1918, April 11	800 00	
	R. McElree	do do	1918, April 11	750 00	

D. GEO. ROSS,
Accountant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 2.

List of Agents for the year ending October 31st, 1918.

Name.	Post office address	District of County.	Date of appointment.	Salary per annum.	Remarks.
		Land Agents.			
Anderson, T. V.	Hearst	Part District of Algoma	1913, May 9	600 00	
Arthurs, E.	Espanola Mills	do do do	1915, May 7	200 00	
Baker, R. H.	Minden	Part Victoria	1907, Oct. 1	350 00	
Bolger, J. W.	New Liskeard	Lake Temiskaming, District of Nipissing	1913, July 17	900 00	
Both, C.	Denbigh	Part of Frontenac and Addington	1905, Oct. 20	200 00	
Brown, John	Markstay	Part of District of Nipissing and Sudbury	1916, June 27	500 00	
Brown, J. B.	Bracebridge	Muskoka District	1905, July 28		For salary see Homestead Inspector.
Burrows, W. A.	Port Arthur	Part District of Thunder Bay	1912, Jan. 30	1,000 00	
Cameron, W.	Stratton Station	do do Rainy River	1911, April 27	500 00	
Campbell, I. M.	Parry Sound	do do Parry Sound	1914, Nov. 12	500 00	
Dempsay, S. J.	Cochrane	do do Nipissing	1911, Feb. 9	1,000 00	
Dodds, T.	Thessalon	do do Algoma	1915, May 4	500 00	
Douglas, W. J.	Maynooth	do Hastings	1912, June 12	500 00	
Ellis, H. J.	Powassan	do District of Parry Sound	1909, May 21	500 00	
Freeborn, Dr. J. S.	Magnetawan	do do do	1905, Nov. 10	500 00	
Gibson, J. E.	Dryden	District of Rainy River	1914, Nov. 20	800 00	
Ginn, F. E.	Matheson	Part District of Nipissing	1912, Mar. 20	900 00	
Hales, W.	Apsley	do County of Peterborough	1911, July 20	250 00	
Hollands, C. J.	Fort Frances	do Townplot of Alberta and part District of Rainy River	1892, Oct. 12	300 00	
Jenkin, W.	Emsdale	do District of Parry Sound	1908, July 29	500 00	
McFayden, A.	Emo	do do Rainy River	1905, Sept. 8	500 00	
MacLennan, J. K.	Sudbury	do do Sudbury	1905, July 3	700 00	
Noble, E.	Sault Ste. Marie	do do Algoma	1913, Feb. 1	300 00	
Parsons, W. J.	North Bay	do do Nipissing	1908, April 8	700 00	
Philion, J. A.	Sturgeon Falls	do do do	1907, Sept. 13	500 00	
Prince, A.	Wilno	do of Renfrew	1905, July 12	500 00	
Small, R.	Mattawa	do District of Nipissing	1910, June 30	500 00	
Spry, W. L.	Kenora	do do Rainy River	1909, Sept. 21	600 00	Also Mining Recorder.
Teasdale, R. A.	Massey	do do Sudbury	1917, July 1	500 00	
Watt, F.	Pembroke	do of Renfrew	1913, May 28	300 00	
Whybourne, W. E.	Marksville	do of St. Joseph Island	1905, April 7	300 00	
Wilson, A. N.	Kinmount	do of Peterborough	1915, June 1	175 00	
Woolings, J.	Englehart	do of District of Nipissing	1908, June 30	700 00	

Appendix No. 2.—Continued.

List of Agents for the year ending October 31st, 1918.

Name.	Post office address	District of County.	Date of appointment.	Salary per annum.	Remarks.
		Homestead Inspectors.			
Barr, J.	Fort Frances	District of Rainy River	1906, Nov. 23	1,200 00	
Bastien, J. A.	Chelmsford	W. part of Sudbury District	1913, May 2	900 00	
Brown, J. B.	Bracebridge	Muskoka District	1905, July 28	1,000 00	Also Crown Lands Agent.
Burnes, C. W.	South River	Parry Sound District	1905, Nov. 15	1,000 00	
Cragg, W. V.	New Liskeard	S. part of Temiskaming District	1913, Mar. 27	1,200 00	
Dean, T.	Sault Ste. Marie.	Algoma District	1908, July 29	800 00	
Hughes, T.	Murillo	Thunder Bay District	1908, July 20	1,000 00	
Quenneville, I.	Sturgeon Falls	E. part Sudbury and W. part Algoma Districts	1906, May 7	900 00	Resigned February 28, 1918.
Owens, H. B.	Cache Bay	E. part Sudbury and W. part Algoma Districts	1918, June 25	800 00	
Smith, D.	Cochrane	N. part of Temiskaming District	1912, April 16	1,500 00	
Watson, T. P.	Englehart	Centre part of Temiskaming District	1905, May 10	1,200 00	
Wigle, R. G.	Dryden	Kenora District	1914, May 27	1,200 00	
		Timber Agents.			
Bremner, G.	Cochrane	Part Temiskaming and Algoma Districts	1913, May 20	1,800 00	
Christie, W. P.	Parry Sound	Part Parry Sound and Muskoka Districts	1903, Dec. 4	1,600 00	
Darby, E. J.	Ottawa	Part Ottawa District	1889, July 26	1,500 00	
Hawkins, S. J.	Webbwood	Part Algoma and Sudbury Districts	1905, Aug. 16	1,600 00	
Henderson, C.	Sudbury	do do	1902 Jan. 1	2,000 00	
Huckson, A. H.	Sault Ste. Marie.	Part District of Algoma	1914, April 1	1,800 00	
Johnson, S. M.	Arnprior	Part Ottawa and Parry Sound Districts	1907, Jan. 11	1,600 00	Died November 22, 1917.
MacDonald, S. C.	New Liskeard	Part Temiskaming District	1907, Jan. 21	1,700 00	
Margach, W.	Kenora	Kenora District	1889, May 16	1,600 00	
McDonald, H.	Thessalon	Part District of Algoma	1905, April 20	1,500 00	
McDougall, J. T.	North Bay	Nipissing and Part Sudbury District	1908, July 8	1,700 00	
Oliver, J. A.	Port Arthur	Thunder Bay District	1905, Sept. 30	1,700 00	
Stevenson, A.	Peterborough	Belleville	1905, Oct. 4	1,500 00	
Watts, G.	Fort Frances	Rainy River District	1910, April 19	1,500 00	Resigned October 1, 1918.
Wood, W. G. A.	South Porcupine.	Porcupine District	1917, Feb. 28	1,400 00	

		Mining Recorders.			
Browning, A. J.	Elk Lake	Montreal River Mining Division	1913, July 15	1,200 00	Died April 30, 1918.
Campbell, C. A.	Sudbury	Sudbury Mining Division	1910, Jan. 6	1,200 00	
Gauthier, G. H.	South Porcupine.	Porcupine Mining Division	1912, July 16	1,500 00	
Hough, J. A.	Matheson	Larder Lake Mining Division	1907, May 22	1,400 00	
Miller, N.	Sault Ste. Marie.	Sault Ste. Marie Mining Division	1915, June 9	1,100 00	
Morgan, J. W.	Port Arthur	Port Arthur Mining Division	1906, Dec. 28	1,100 00	
Morgan, M. R.	Tashota	Kowkash Mining Division	1916, Mar. 10	1,000 00	Resigned August 31, 1918.
McAulay, N. J.	Haileybury	Temiskaming Mining Division	1915, May 8	1,900 00	
McQuire, H. F.	Parry Sound	Parry Sound Mining Division	1906, Sept. 26	500 00	
Sheppard, H. E.	Elk Lake	Gowganda Mining Division	1909, Feb. 10	1,100 00	
Spry, W. L.	Kenora	Kenora Mining Division	1909, Sept. 21	900 00	Also Crown Lands Agent.
		Emigration Agents.			
Reid, R.	London	England	1913, Feb. 7	6,500 00	Died October 21, 1918.
Clark, J. M.	London	do	1913, Mar. 17	3,500 00	

D. GEO. ROSS,
Accounant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 3.

Statement of Lands Sold and Leased. Amount of Sales and Leases and Amount of Collections for the year ending October 31st, 1918.

Service.	Acres sold and leased.	Amount of sales and leases.	Collection on sales and leases.
Lands Sold:		$ c.	$ c.
Agricultural and Townsites	51,401.22	39,775 01	50,253 53
Mining	12,125.64	32,180 67	33,535 58
Clergy Lands	....	....	355 40
Common School Lands	292.00	906 50	7,341 97
Grammar School Lands	47.00	58 75	288 00
University Lands	1,288.25	786 01	1,417 31
Lands Leased:			
Mining	3,119.46	3,040 04	14,009 15
Crown	35,424.36	3,535 45	68,700 58
Temagami	3.66	63 00	1,064 65
	103,701.59	80,345 43	176,966 17

D. GEO. ROSS,
Accountant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 4.

Statement of Revenue of the Department of Lands, Forests and Mines for the year ending October 31st, 1918.

Service.	$ c.	$ c.	$ c.
LAND COLLECTIONS.			
Crown Lands:			
Agricultural	45,748 83		
Townsites	4,504 70		
		50,253 53	
Mining Sales		33,535 58	
Clergy Lands	355 40		
Common School Lands	7,341 97		
Grammar School Lands	288 00		
University Lands	1,417 31		
		9,402 68	
			93,191 79
Rent:			
Mining Leases	14,009 15		
Temagami Leases	1,064 65		
		15,073 80	
Crown Leases	19,628 53		
Sand and Gravel Royalty	29,464 21		
" " Rentals	3,469 66		
Water Powers	15,016 68		
Algonquin Provincial Park	1,121 50		
		68,700 58	
			83,774 38
Miners' Licenses	24,035 60		
Permits	945 00		
Recording Fees	27,291 26		
		52,271 86	
Supplementary Revenue:			
Acreage Tax	29,301 62		
Profit Tax	863,547 75		
Gas Tax	26,359 43		
		919,208 80	
			971,480 66
WOODS AND FORESTS.			
Bonus		679,304 17	
Timber Dues		795,004 08	
Ground Rent		87,263 93	
Transfer Fees		4,740 00	
Fire Protection		189,773 07	
			1,756,085 25
Provincial Assay Fees	722 35		
Casual Fees	976 00		
Cullers' Fees	80 00		
Forest Reserves Guides' Fees	130 00		
		1,908 35	
Algonquin Provincial Park	17,982 93		
Quetico Provincial Park	1 00		
		17,983 93	
Sale of Provincial Ore		1,384 53	
			21,276 81
REFUNDS.			
Forest Ranging		33,381 77	
Fire Ranging		1,930 15	
Surveys		1,161 70	
Algonquin Park Cleaning Right-of-Way		1,117 61	
Contingencies		246 43	
Colonization		207 57	
Agents' Salaries		155 80	
Insurance		59 15	
Mines and Mining		47 50	
Advertising		25 00	
Mining Recorders'		11 44	
Forest Reserves		4 75	
Mineral Display at Exhibitions		4 00	38,352 87
			2,964,161 76

D. GEO. ROSS,
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ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 5.

Statement of Receipts of the Department of Lands, Forests and Mines for the year ending October 31st, 1918, which are considered as Special Funds.

Service.	$ c.	$ c.
Clergy Lands.		
Principal	149 44	
Interest	205 96	
		355 40
Common School Lands.		
Principal	4,142 81	
Interest	3,199 16	
		7,341 97
Grammer School Lands.		
Principal	180 00	
Interest	108 00	
		288 00
University Lands.		
Principal	1,031 88	
Interest	385 43	
		1,417 31
		$9,402 68

D. GEO. ROSS,
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ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 6.

Statement of Disbursements of the Department of Lands, Forests and Mines, for the year ending October 31st, 1918.

Service.	$ c.	$ c.	$ c.
AGENTS' SALARIES AND DISBURSEMENTS.			
Land, $18,202.13.			
Anderson, T. V.	600 00		
Disbursements	33 50		
		633 50	
Arthurs, E.		200 00	
Baker, R. H.	350 00		
Disbursements	7 27		
		357 27	
Bolger, J. W.	900 00		
Disbursements	186 83		
		1,086 83	
Both, C.	....	200 00	
Brown, John	500 00		
Disbursements	16 37		
		516 37	
Burrows, W. A.	1,000 00		
Disbursements	289 95		
		1,289 95	
Cameron, W.	500 00		
Disbursements	24 50		
		524 50	
Campbell, Miss I. M.	500 00		
Disbursements	15 00		
		515 00	
Dempsay, S. J.	1,000 00		
Disbursements	55 00		
		1,055 00	
Dodds, T.	500 00		
Disbursements	11 00		
		511 00	
Douglass, W. J.	....	500 00	
Ellis, H. J.	....	500 00	
Freeborn, J. S.	500 00		
Disbursements	5 00		
		505 00	
Gibson, J. E.	683 32		
Disbursements	151 70		
		835 02	
Ginn, F. E.	841 00		
Disbursements	239 80		
		1,080 80	
Hales, W.	....	250 00	
Hollands, C. J.	....	300 00	
Jenkin, W.	500 00		
Disbursements	7 11		
		507 11	
McFayden, A.	500 00		
Disbursements	45 65		
		545 65	
MacLennan, J. K.	....	700 00	
Carried forward	....	12,613 00	

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		12,613 00	
AGENTS' SALARIES AND DISBURSEMENTS—*Continued.*			
Land.—Concluded.			
Noble, E.		300 00	
Parsons, W. J.	641 66		
Disbursements	159 40		
		801 06	
Philion, J. A.	500 00		
Disbursements	19 32		
		519 32	
Prince, A.	500 00		
Disbursements	28 50		
		528 50	
Small, R.	500 00		
Disbursements	22 75		
		522 75	
Spry, W. L.	600 00		
Disbursements	290 25		
		890 25	
Teasdale, R. A.	500 00		
Disbursements	6 00		
		506 00	
Watt, F.		300 00	
Whybourne, W. E.	300 00		
Disbursements	3 75		
		303 75	
Wilson, A. N.	175 00		
Disbursements	7 50		
		182 50	
Woollings, J.	700 00		
Disbursements	35 00		
		735 00	
Homestead Inspectors, $14,978.75.			
Barr, J.	1,200 00		
Disbursements	500 25		
		1,700 25	
Bastien, J. A.	900 00		
Disbursements	99 75		
		999 75	
Brown, J. B.	1,000 00		
Disbursements	314 41		
		1,314 41	
Burnes, C. W.	1,000 00		
Disbursements	134 39		
		1,134 39	
Cragg, W. V.	1,200 00		
Disbursements	230 92		
		1,430 92	
Dean, T.	800 00		
Disbursements	109 30		
		909 30	
Hughes, T.	1,000 00		
Disbursements	593 90		
		1,593 90	
Owens, H. B.	266 66		
Disbursements	136 35		
		403 01	
Carried forward		27,688 06	

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	27,688 06	
AGENTS' SALARIES AND DISBURSEMENTS—*Continued.*			
Homestead Inspectors.—Concluded.			
Quenneville, I.	300 00		
Disbursements	80 80		
		380 80	
Smith, D.	1,500 00		
Disbursements	376 87		
		1,876 87	
Watson, T. P.	1,200 00		
Disbursements	412 05		
		1,612 05	
Wigle, R. G.	1,200 00		
Disbursements	423 10		
		1,623 10	
Timber, $31,088.07.			
Bremner. G.	1,800 00		
Disbursements	332 24		
		2,132 24	
Christie, W. P.	1,600 00		
Disbursements	276 68		
		1,876 68	
Hawkins, S. J.	1,550 00		
Disbursements	315 08		
		1,865 08	
Henderson, C.	2,000 00		
Webster, W. A., Assistant	505 00		
Disbursements	262 20		
		2,767 20	
Huckson, A. H.	1,616 67		
Disbursements	459 84		
		2,076 51	
Johnson, S. M.	133 00		
Disbursements	304 58		
		437 58	
MacDonald, S. C.	1,700 00		
Disbursements	135 53		
		1,835 53	
Margach, W.	1,600 00		
Legris, J., Assistant	1,600 00		
Cunningham, E. A., Stenographer	456 50		
Disbursements	639 43		
		4,295 93	
McDonald, H.	1,500 00		
Disbursements	178 83		
		1,678 83	
McDougall, J. T.	1,700 00		
Disbursements	515 86		
		2,215 86	
Oliver, J. A.	1,700 00		
Porter, M., Stenographer	70 95		
Campbell, M., Stenographer	486 53		
Disbursements	801 34		
		3,058 82	
Stevenson, A.	1,500 00		
Disbursements	338 95		
		1,838 95	
Carried forward		59,260 09	

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	59,260 09	
AGENTS' SALARIES AND DISBURSEMENTS.—*Concluded.*			
Timber.—Concluded.			
Watts, G.	1,500 00		
McDonald, A., Assistant	1,500 00		
Disbursements	249 29		
		3,249 29	
Wood, W. G. A.	1,300 00		
Disbursements	459 57		
		1,759 57	
Miscellaneous, $2,772.90.			
Bilton, G., Caretaker, Islands in North and South Crosby	....	31 25	
Butler, E. W. D., Valuating Water Lots, Port Arthur	....	500 00	
Guthrie, W., Caretaker, Islands in Devil's Lake		25 00	
Jamieson, W. H., Caretaker, Islands in Dog and Laboria Lakes		50 00	
Long, H. E., Building and Equipment, South Porcupine		900 00	
McArthur, T. A., Inspector of Agencies	748 00		
Disbursements	518 65		
		1,266 65	
			67,041 85
OTTAWA AGENCY.			
Darby, E. J., Agent		1,500 00	
Larose, S. C., Clerk		1,000 00	
Rent	700 00		
Disbursements	107 95		
		807 95	
			3,307 95
FOREST RANGING, *$125,474.84.*			
Acheson, I. M.	....	1,613 50	
Allanson, J. A.	....	515 00	
Allen, R. A.	....	1,067 00	
Alk, J. C.	....	106 00	
Arnill, Wm.	....	1,534 00	
Bailey, A.	....	940 00	
Baldson, Geo	....	95 00	
Barrett, Thos.	....	764 50	
Bates, R.	....	735 00	
Benning, J.	....	33 00	
Blastorah, B.	....	320 00	
Boice, R.	....	112 00	
Boiley, H.	....	124 00	
Braman, C.	....	103 00	
Bremner, G. A. .... Disbursements	....	74 38	
Bromley, Ed.	....	895 50	
Bromley, T. A.	....	1,185 00	
Brooks, J. W.	....	895 00	
Brown, J. A.	....	1,287 00	
Buisson, Wm.	....	690 00	
Carroll, P.	....	297 00	
Castonguay, A. C.	....	687 50	
Charlebois, E.	....	225 00	
Chenier, D. A.	....	1,721 50	
Christie, W. P. .... Disbursements	....	5 20	
Clairmont, E.	....	715 00	
Carried forward	....	16,740 08	70,349 80

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		16,740 08	70 349 80
FOREST RANGING.—*Continued.*			
Clark, W. R.		709 50	
Cloud, Wm.		343 00	
Comer, B. F.		630 00	
Connelly, D.		745 00	
Corrigan, R. T.		1,661 00	
Coyne, P.		775 00	
Cross, R. J.		725 00	
Cullen. M.		200 00	
Curly, Miss V. ....Stenographer		194 99	
Dawkins, J. J.		962 50	
Dennie, F. J.		891 00	
Didier, H.		995 00	
Dillon, J. R.		1,235 00	
Doxsee, J. E.		623 00	
Dulmage, J.		15 00	
Dunn, J. F.		825 00	
Durrell, Wm.		1,699 00	
Duval, C. A.		830 50	
Elliott, Ed.		21 00	
Fairbairn, N. H.		555 50	
Ferguson, A. E.		980 00	
Fisher, Geo.		1,116 50	
Fletcher, N.		885 50	
Fraser, W. A.		711 00	
Fraser, R. T.		477 00	
Graham, Chas.		156 00	
Hagan, E. G.		951 50	
Hale, John		460 00	
Hamburg, M. A.		52 00	
Hamilton, Fred.		702 00	
Hand, Thos.		20 00	
Harris, C.		260 00	
Hart, I.		699 00	
Hartley, C.		1,435 50	
Harvey, A.		72 00	
Hawkins, S. J.		112 80	
Henderson, A. E.		637 00	
Henderson, L. E.		1,595 00	
Henderson, A. E.		709 50	
Henderson, Chas. ....Disbursements		866 88	
Hey, Ben.		795 00	
Hoff, M.		918 50	
Hogan, J.		560 00	
Hogarth, J.		925 00	
Huckson, E.		156 00	
Huckson, A. H. ....Disbursements		827 41	
Hurdman, W. H.		715 00	
Hutton, John		1,523 50	
Jamieson, J.		645 00	
Jeroux, A.		132 00	
Johnson, Wm.		28 00	
Kelley, T.		730 50	
Kernahan, G. A.		645 00	
Kitchen, James		52 00	
Lagennesse, Leo.		72 00	
Latour, F.		104 00	
Lee, J. B.		990 00	
Legris, J. ....Disbursements		153 30	
Leroy, L. H.		695 00	
Carried forward		54,942 46	70 349 80

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		54,942 46	70 349 80
FOREST RANGING.—*Continued.*			
Lilevre, J.		93 00	
Linklater, Geo.		214 50	
Little, T.		630 00	
Lowe, W. C.		565 00	
MacDonald, S. C. ....Disbursements		50	
Macdonell, R. D.		790 00	
Manice, Wm.		1,435 50	
Margach, Wm. ....Disbursements		1,316 85	
Margach, J. A.		1,595 00	
Menzies, Alex.		1,870 00	
Milway, J. H.		1,056 00	
Molyneaux, Geo.		863 50	
Moody, L. A.		630 00	
Mooney, L.	1,967 00		
Disbursements	168 14		
		2,135 14	
Moran, A.		1,870 00	
Morel, A.		134 50	
Murray, Wm.		2,216 50	
Murray, Thos.	250 00		
Disbursements	25 60		
		275 60	
McAulay, W. D.		805 00	
McCallum, A.		200 00	
McCaw, J. E.		775 00	
McCaw, J. G.	1,864 50		
Disbursements	43 30		
		1,907 80	
McDonald, J. D.		1,864 50	
McDonald, Thos.		614 50	
McDonald, F.		56 00	
McDonald, Hector ....Disbursements		33 75	
McDonnell, J. R.		880 00	
McDougall, J. T. ....Disbursements		206 35	
McFarlane, J. D.		561 00	
McGillivray, D. D.		510 00	
McGregor, W. H.		216 00	
McGuire, C.		279 00	
McIvor, J. A.		1,170 00	
McKendry, W. B.		830 00	
McLaughlin, John		647 00	
McLay, A.		690 00	
McLean, John		1,941 50	
McLeod, E. H. ....Disbursements		14 72	
McNabb, A.		870 00	
McPherson, J. S.		1,798 50	
Nault, James		1,609 00	
Nephew, D.		150 00	
Nevison, W. H.		778 25	
Niblett, James		1,413 50	
Ogden, L. M.		570 00	
Oldschamp, R.		165 00	
Oliver, J. A. ....Disbursements		575 77	
Pigott, J. A.		1,430 00	
Poulin, C.		88 00	
Pritchard, Fred		410 00	
Regan, John		484 00	
Reid, J. P.		1,035 00	
Richardson, C. R.		645 00	
Carried forward		98,858 19	70 349 80

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		98,858 19	70 349 80
FOREST RANGING.—*Concluded.*			
Ridley, R.		1,575 75	
Ritchie, J. F.		925 00	
Ross, S.		1,498 50	
Ryan, James		1,147 00	
Schrieber, C. C.		539 00	
Shaw, Alfred	605 00		
Disbursements	15 00		
		620 00	
Shaw, D.		435 00	
Sharp, James		865 00	
Short, J.		500 00	
Simpson, Wm.		1,645 00	
Sissons, H. P.		320 00	
Smith, J. D. C.		745 00	
Spafford, Thos.		200 00	
Spavin, J.		1,130 00	
Spence, D.		1,721 50	
Stein, Paul		1,680 00	
Stevenson, A. ... Disbursements		110 90	
Stewart, D.	600 00		
Disbursements	7 00		
		607 00	
Thorpe, Thos.	987 00		
Disbursements	14 45		
		1,001 45	
Trowse, A. E.		599 50	
Urquhart, A.		990 00	
Vanderburg, N.		902 00	
Vincent, H. T.		1,853 50	
Warri, F.		52 00	
Watts, Fred		156 00	
Watts, J. J.		25 00	
Watts, Geo. ... Disbursements		114 95	
Whelan, P. J.	1,870 00		
Disbursements	137 90		
		2,007 90	
Whelan, P. M.		55 00	
Williams, P.		126 00	
Wilson, D.		920 00	
Wilson, Alex.		475 00	
Wood, W. G. A. ... Disbursements		62 45	
Wylie, B.		11 00	
Youmans, D.		55 25	
Young, R. J.		745 00	
Yuill, John		200 00	
			125,474 84
FIRE RANGING.			
Abbott, Wm.		378 50	
Abraham, M.		214 50	
Adams, A.		433 75	
Agnew, Wm.		173 25	
Alt, John		222 75	
Allen, R. A.	845 00		
Disbursements	348 76		
		1,193 76	
Allen, Wm.		418 00	
Ambridge, Wm.		60 00	
American Tent and Awning Co., ... Supplies		240 00	
Anderson, John		200 75	
Carried forward		3,535 26	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	3,535 26	195,824 64
FIRE RANGING.—*Continued.*			
Anderson, James	....	291 50	
Anderson, Robert	....	393 25	
Anger, T.	....	321 75	
Archambault, G.	....	409 75	
Arnott, T. W.	....	167 75	
Atkison, A. C.	....	286 00	
Aubee, T.	....	390 50	
Aymor, A. J.	....	302 50	
Babin, J.	....	225 00	
Baker, Wm.	....	390 50	
Baldwin, Steve	....	379 50	
Baldwin, Wm.	....	379 50	
Bandin, J.	....	16 50	
Banks, E.	....	230 25	
Barratt, J.	....	250 75	
Barrie, T.	....	420 75	
Barry, C.	....	404 25	
Bartlett, S.	....	192 50	
Barton, J.	....	393 25	
Bartrand, Wm.	....	341 00	
Baskin, L.	....	327 25	
Basso, A. N.	....	77 00	
Bates, R.	....	280 50	
Bauman, Theo.	....	341 00	
Beatty, W. A.	....	371 25	
Beatty, H.	....	7 00	
Beaudry, J.	....	354 75	
Beaudry, M.	....	382 25	
Beauvis, P.	....	379 50	
Beauvis, J.	....	379 50	
Bedard, J.	....	379 50	
Bedford, H.	....	397 75	
Bedford, O.	....	39 00	
Begin, A.	....	376 75	
Belcher, E. D.	....	400 50	
Bell, W.	....	55 00	
Bell, J.	....	376 75	
Bellefull, O.	....	393 25	
Beleveau, F.	....	342 75	
Belton, W. J.	387 75		
Disbursements	4 40		
		392 15	
Benard, D.	....	108 50	
Benson, M.	....	41 25	
Bergeron, Alf.	....	360 25	
Bernoche, G.	....	346 50	
Bernier, C.	....	379 50	
Bernier, Z.	....	338 25	
Bird, John	....	368 50	
Bisson, Art.	....	417 00	
Blair, H. L.	....	24 75	
Blanchette, H.	....	335 50	
Blaski, F.	....	396 00	
Bliss, L. E.	3,000 00		
Disbursements	1,632 21		
		4,632 21	
Blonaim, E.	....	38 50	
Blondin, A.	....	313 50	
Boiley, H.	....	514 25	
Bois, L.	....	393 25	
Carried forward	....	24,783 12	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	24,783 12	195,824 64
FIRE RANGING.—*Continued.*			
Boissoneault, J.	....	398 75	
Boivin, J.	....	403 25	
Boldt, A.	....	382 25	
Bonathan, Wm.	....	415 25	
Bonsteel, H.	....	551 25	
Bookhout, H.	....	308 00	
Boucher, C.	....	453 75	
Boucher, S.	....	154 00	
Boucher, J.	....	184 25	
Bourke, P.	....	382 50	
Bourassa, E.	....	117 00	
Bowes, John	....	401 50	
Bowers, Geo.	....	376 75	
Bowland, J. J.	920 00		
Disbursements	1,121 26		
		2,041 26	
Bowles, J.	....	374 00	
Boyce, B.	....	382 25	
Boyes, N.	....	409 75	
Boyd, John	....	155 00	
Boyd, J.	....	302 50	
Bozalie, E.	....	101 75	
Brant, H.	....	272 25	
Brear, Geo.	....	393 25	
Bremer, C. E.	....	401 50	
Brennan, G.	....	368 50	
Brennan, R. L.	....	401 50	
Brensten, H.	....	154 00	
Bresenham, J.	....	349 25	
Brock, W. R., & Co. .... Supplies	....	2,313 86	
Bromley, E. H.	573 25		
Disbursements	177 05		
		750 30	
Bromley, J. C.	....	338 25	
Brooke, A. T.	....	178 75	
Brooks, Wesley	....	327 25	
Brown, E.	....	137 50	
Brown, T. E.	....	429 00	
Brown, J. F.	....	405 00	
Brown, A.	....	382 25	
Brown, August	....	368 50	
Brown, W.	....	431 75	
Brown, Wm.	....	77 00	
Brown, John	....	371 25	
Brown, H.	....	291 50	
Brown, W. C.	....	244 75	
Brum, A. W.	840 00		
Disbursements	722 10		
		1,562 10	
Bryant, W.	....	478 50	
Buckingham, J. P.	....	387 75	
Bull, W.	....	370 25	
Bull, W. H.	....	407 00	
Bulmer, A.	....	365 75	
Bunting, H. T.	....	379 50	
Burns, F.	....	359 25	
Burns, J.	....	88 00	
Butler, W. J.	....	170 50	
Cahoun, John	....	137 50	
Calder, Ed.	....	228 25	
Carried forward	....	47,399 64	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		47,399 64	195,824 64
FIRE RANGING.—*Continued.*			
Cameron, N.		225 50	
Cameron, Jos.		247 50	
Cameron, Wm.		299 75	
Cameron, Archie		360 25	
Cameron, M. H.		393 25	
Cameron, J. K.	628 00		
Disbursements	14 35		
		642 35	
Campbell, S.		101 75	
Campbell, J.		313 50	
Campbell, J. R.		319 00	
Campbell, D.		433 75	
Campbell, W.		584 00	
Campbell, R.		406 00	
Campbell, A.		379 50	
Campbell, T. J.		305 25	
Campbell, K. W.		371 25	
Campbell, Thos.		415 25	
Campbell, Wesley		407 00	
Canadian Northern Express Co. ....Express		6 20	
Canadian Express Co. ....Express		4 12	
Canadian Pacific Railway Co. ....Freight charges		8 22	
Canadian Fairbanks-Morse Co. ....Equipment		4,108 54	
Caney, Thos.		85 25	
Canning, J.		387 75	
Canora, Jos.		316 25	
Carew, John, Lumber Co.		112 50	
Carino, F.		3 50	
Caron, F.		126 50	
Carlton, T.		381 25	
Carpenter, G. G.		382 25	
Carrier, E.		134 75	
Caswell, R.		379 50	
Caswell, S.		129 25	
Caswell, M.		258 50	
Cates, Jos.		382 25	
Cave, J. E.		19 25	
Chaffey, Wm.		390 50	
Chamberlain, H.		371 25	
Chambers, Thos.		401 50	
Chapman, John		280 50	
Chapman, C. N.		286 00	
Chappish, J.		280 50	
Charlebois, E.		38 50	
Charron, J.		470 25	
Chartrand, M.		123 75	
Chase, J. F.		396 00	
Chaundant, H.		121 00	
Chautal, Art.		5 50	
Chief, T.		173 25	
Chief, N.		159 50	
Chippier, M.		401 50	
Christianson, J.		23 50	
Clark, W. R.	815 00		
Disbursements	919 06		
		1,734 06	
Cleary, J. F.		88 25	
Clegg, R.		225 50	
Clegg, F.		141 00	
Carried forward		66,942 13	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		66,942 13	195,824 64
FIRE RANGING.—*Continued.*			
Clergue, D.		154 00	
Cochrane, H.	396 00		
Disbursements	2 40		
		398 40	
Codere, H.		401 50	
Coghlan, T. E.		370 25	
Coghlan, Thos.		401 50	
Coghlan, J. S.		368 50	
Coleman, E. J.		403 25	
Conklin, Wm.		393 25	
Conroy, Ed.		324 50	
Conway, R.		401 50	
Conway, Thos.		374 00	
Conway, H.		379 50	
Cook, Geo.		4 00	
Cook, Wm.		379 50	
Cooney, Thos.		385 00	
Corps, A. C.		352 00	
Coshette, T.		44 00	
Cotte, H.		359 25	
Cottenham, Wm.		387 75	
Couorette, J.		418 00	
Cowan, J.		352 00	
Cox, Jos.		396 00	
Coyne, P.	268 00		
Disbursements	52 20		
		320 20	
Craig, John		385 00	
Crawford, John		706 50	
Cross, C. C.		173 25	
Cryer, P.		8 25	
Cuddy, J.		390 50	
Culbert, D. S.		367 50	
Culhane, Dan.		239 25	
Culhane, A.		299 75	
Culhane, D.		390 50	
Cullen, G. B.		211 75	
Cummer, W. T.		156 75	
Cummins, Thos.	308 00		
Disbursements	19 40		
		327 40	
Cummins, Frank		286 00	
Currie, T. A. G.		286 00	
Curtin, Dave		396 00	
Curtis, John		354 75	
Dagg, A.		173 25	
Dalman, J.		327 25	
Dambremont, F.		220 00	
Dancer, Geo.		123 75	
Dane, Alf.		396 00	
Darby, Wm.	915 00		
Disbursements	1,409 86		
		2,324 86	
Davidson, Ira		379 50	
Davidson, John		414 25	
Davies, A.		44 00	
Davis, Thos.		376 75	
Dawkins, J. J.	600 00		
Disbursements	130 78		
		730 78	
Carried forward		85,199 52	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		85,199 52	195,824 64
FIRE RANGING.—*Continued.*			
Dawson, Geo.		115 50	
DeLabarre, H.		368 00	
Dennie, F. J.	790 00		
Disbursements	342 14		
		1,132 14	
Dennison, H. J.		401 50	
Deschamp, F.		363 00	
Deschamp, J.		44 00	
Deschamp, P.		55 00	
Desjordina, W.		46 50	
Derouard, M.		396 00	
Derouin, James		379 50	
Derouin, A.		354 75	
Dery, Jos.		349 25	
Deschine, J.		332 75	
Desellier, P.		148 50	
Dewett, John		68 75	
Dickson, W. D.		401 50	
Dickson, J.		280 25	
Dixson, Geo.		101 75	
Dobie, T.		418 00	
Dodds, A.		341 00	
Dodge, Thos.		404 25	
Dominion Express Co. .... Express		18 18	
Domoulin, D.		73 50	
Domoulin, P.		33 00	
Donaldson, John		352 00	
Donaldson, C.		382 25	
Donis, P.		376 75	
Douchine, D.		231 00	
Douchine, S.		338 25	
Dougherty, Chas.		286 00	
Douglas, J. R.		203 75	
Douglas, D. B.		253 00	
Douglas, Thos.		371 25	
Dowadal, D.		365 75	
Dowd, H. L.		393 25	
Downey, Geo.		206 75	
Dowsett, R. E.		631 50	
Dubreuiel, A.		376 75	
Dubrois, Wm.		343 75	
Ducharme, D.		360 25	
Dufoe, B.		210 50	
Dufresne, D.		233 75	
Duke, D.		348 25	
Duma, Alex.		385 00	
Dumont, A.		167 75	
Dumont, O.		374 00	
Dumont, P.		24 75	
Dunbar, James		393 25	
Duncan, R.		376 75	
Dunn, J.		371 25	
Dunning, J. R.		184 25	
Dupine, Hy.		420 75	
Dupuis, O.		393 25	
Dupuis, Ed.		187 00	
Duquette, Chas.		390 50	
Duquette, H.		379 50	
Duval, C. A.	1,284 00		
Disbursements	1,461 31		
		2,745 31	
Carried forward		104,884 15	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		104,884 15	195,824 64
FIRE RANGING.—*Continued.*			
Edwards, W. C.		288 00	
Edwick, C. G.		390 50	
Elleston, R.		237 00	
Elliotte, C. H.		376 75	
Elliotte, J.		140 25	
Elliss, E. C.		433 13	
Ellsworth, C. B.		387 75	
Emery, J.		386 75	
Emes, Hugh		393 25	
Ennis, S.		324 50	
Espanoil, A.		294 25	
Evans, W. J.	980 00		
Disbursements	1,024 19		
		2,004 19	
Everett, L.		299 75	
Fairbairn, N. H.		343 75	
Falshaw, R.		404 25	
Farr, W. F.		224 00	
Faudette, J.		33 00	
Favelle, T. W.		96 25	
Favreau, Geo.		225 50	
Fecto, Geo.		415 25	
Ferand, Geo.		402 50	
Ferguson, A.		406 00	
Ferguson, E. A.		99 00	
Ferguson, T. H.	584 00		
Disbursements	3 69		
		587 69	
Ferguson, F.		390 50	
Ferguson, J.		403 25	
Ferris, R.		80 00	
Field, Wm.		308 00	
Filion, D.		291 50	
Filliatrault, J.		384 00	
Findley, Jas.		434 50	
Finlayson, J. L.		19 25	
Finlayson, J.		305 25	
Finlayson, J. H.		431 75	
Finlayson, D.		261 25	
Finn, J.		220 00	
Firby, L. C.		216 00	
Fisher, Geo.	765 00		
Disbursements	594 39		
		1,359 39	
Fitzgerald, Jas.		393 25	
Flaherty, John		387 75	
Flanagan, W. J.		108 00	
Fleming, F. L.	576 00		
Disbursements	82 05		
		658 05	
Fletcher, N. B.	620 00		
Disbursements	47 70		
		667 70	
Fletcher, A.		162 00	
Fleurie, Andy		354 75	
Flynn, Pat.		396 00	
Forman, A.		396 00	
Forster, A. T.		152 25	
Carried forward		122,857 80	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		122,857 80	195,824 64
FIRE RANGING.—*Continued.*			
Fortin, J. T.		338 25	
Foster, F.		141 00	
Foster, R.		371 25	
Foucailt, A.		363 00	
Fournier, J.		233 75	
Francois, J. S.		253 00	
Franklin, John		52 25	
Fraser, A.		376 75	
Fraser, W. A.		431 75	
Fraser, Chas.		63 25	
Frecette, B.		393 25	
Frenette, Leo		60 50	
French, Lorn		379 50	
Frith, A.		313 50	
Furlong, J.		401 50	
Gagne, F.	825 00		
Disbursements	688 94		
		1,513 94	
Gagnon, F.		192 50	
Gagnon, F.		297 00	
Gagnon, Alex.		396 00	
Gagnon, N.		401 50	
Gamble, J. H.		7 50	
Gamble, Wm.		134 75	
Gardner, S. H.		370 25	
Gartshore, M.		393 25	
Gaudaette, J.		318 00	
Gault, J.		382 25	
Gault, R.		382 25	
Gay, M. W.		13 80	
Gemmill, John	960 00		
Disbursements	527 06		
		1,487 06	
Genereux, S.		376 75	
Gerrard, T.		302 50	
Gervais, F. H.		382 25	
Gervais, F.		382 25	
Gervais, F.		386 75	
Gervais, Jos.		231 00	
Gibbons, O.		376 50	
Gibson, Ed.		393 25	
Gideon, Jos.		363 00	
Gideon, C.		222 75	
Giles, Chas.		7 00	
Godward, E.		380 25	
Gonge, H.		49 50	
Good, W. H.		104 50	
Good, J. R., Advertising Co. .... Supplies		175 00	
Gordon, Alfred		390 50	
Gorman, D.		351 00	
Gosselin, Fred.		126 50	
Graham, C.		335 50	
Graham, J.		374 00	
Grand Trunk Railway Co. .... Freight		1 06	
Granier, J.		314 50	
Grasser, G.		431 75	
Grawberger, Thos.		393 25	
Gray, Peter		401 50	
Great North Western Telegraph Co.		13 89	
Carried forward		140,587 05	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		140,587 05	195,824 64
FIRE RANGING.—*Continued.*			
Green, W. T.		85 25	
Green, Malcolm		82 50	
Grills, S.		355 75	
Groome, L.		349 25	
Grotten, C. A.		140 00	
Groulx, A.		396 00	
Groulx, J.		445 50	
Groulx, A.		445 50	
Groulx, P.		396 00	
Groulx, Chas.		352 00	
Groutte, Dan.		49 50	
Grovers, Jno.		341 00	
Guess, Jos.		346 50	
Guetr, S.		134 75	
Gunderson, A.		376 75	
Gunter, R. H.		396 00	
Gunter, J.		376 75	
Guthrie, Wm.		396 00	
Guy, Fred.		66 00	
Hackenbroich, C.		302 50	
Hagen, C.		393 25	
Hagarty, J.		459 00	
Haggart, L.		94 50	
Haley, Ed.		407 00	
Hall, David		385 00	
Hall, Wm.		371 25	
Hall, John		426 25	
Hall, Thos.		170 50	
Hall, Wesley		387 75	
Halliday, Wm.		412 50	
Hamilton, J. W.		374 00	
Hamilton, Fred.	815 00		
Disbursements	539 57		
		1,354 57	
Hamilton, J.		379 50	
Hammond, W.		408 00	
Hamon, F.		434 50	
Hanbridge, Wm.		276 00	
Hand, Thos.	885 00		
Disbursements	530 47		
		1,415 47	
Hanrahan, D.	515 00		
Disbursements	519 85		
		1,034 85	
Hanson, A.		382 25	
Harkley, Jno.		390 50	
Harney, B.		371 00	
Harney, S.		371 00	
Harper, Wm.		393 25	
Harris, F.		55 00	
Harrison, Geo.		242 00	
Hartford, Wm.		29 20	
Harvie, A.		374 00	
Haskins, W.		407 00	
Hass, Geo.		396 00	
Hastings, J.		390 50	
Hawley, P.		368 50	
Hayes, C.		297 00	
Carried forward		160 071 64	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Carried forward		160,071 64	195,824 64
FIRE RANGING.—*Continued.*			
Hayes, T.		176 00	
Hazard, Geo.		385 00	
Hazard, S. W.		236 50	
Head, W. J.		82 50	
Healy, H.		19 25	
Hebert, J. A.		276 75	
Hefferty, D.		5 50	
Heitman, R.		375 75	
Henderson, John		434 50	
Heney, Jos.		365 75	
Henry, M.		9 20	
Herron, A.		55 00	
Hey, Ben.	845 00		
Disbursements	346 80		
		1,191 80	
Hickey, J. L.	855 00		
Disbursements	644 90		
		1,499 90	
Higgins, John		352 00	
Hill, Chas.		349 25	
Hindson, C. E. Disbursements		20 60	
Hines, E.		210 00	
Hoadley, John		341 00	
Hogan, C.		85 25	
Hogan, J. C.		310 75	
Hogan, P.		409 75	
Hogan, D.		310 75	
Holley, J.		162 25	
Hollingshead, A.		401 50	
Holm, O.		1 50	
Holmes, W. F.		242 00	
Holmes, J.		217 25	
Holt, Wm.		387 75	
Holst, A.		505 75	
Honeyford, W.		356 00	
Horn, A. G.		371 25	
Hornick, Geo.		429 00	
Horsman, H.		371 25	
Holte, J. D.		382 25	
Hubbell, E. S.		103 40	
Hubart, A. R.		288 00	
Hudson's Bay Co.		13 75	
Hume, O. B.		376 75	
Hunter, Wm.		401 50	
Hunter, E.		302 50	
Hunter, L. H.		343 75	
Hurdman, W. H.	615 00		
Disbursements	61 95		
		676 95	
Indian, F.		198 00	
Ireland, G. E.		328 25	
Irish, Wm.		475 50	
Irwin, T.		140 25	
Isaac, M.		141 00	
Isbister, J. A.		390 50	
Jacob, M.		217 25	
James, G.		390 50	
Jarvis, J.		16 50	
Jeneroux, N.		403 25	
Carried forward		176,609 74	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		176,609 74	195,824 64
FIRE RANGING.—*Continued.*			
Jenkins, S.		1,470 00	
Jennings, Fred.		121 00	
Jewell, F.		379 50	
Jewell, E.		402 50	
Jocko, P.		407 00	
Johnson, Wm.		440 00	
Johnston, F. F.		415 25	
Johnston, F. C.		357 50	
Johnston, John		376 75	
Johnston, J. E.		255 75	
Johnston, W. A.		134 75	
Jolicour, J. P.		55 00	
Jones, T.		406 00	
Jones, Chas.		390 50	
Jones, W. T.		387 75	
Jones, W. M.		294 25	
Julian Sale Leather Goods Co.		14 50	
Keating, W.		404 25	
Keeley, C. A.		382 25	
Kellington, W. J.		272 25	
Kelly, R.		18 00	
Kelly, T.		376 75	
Kelly, John		390 50	
Kelly, Geo.		253 00	
Kelly, J.		79 75	
Kennedy, Robt.		376 75	
Kerby, John		379 50	
Kerby, John		264 00	
Kewais, J.		365 75	
Kickley, Wm.		393 25	
Kielty, Geo.		376 75	
Kilby, T.		368 50	
King, R.		393 25	
King's Printer .... Supplies		837 22	
Kingston, Thos. J.		379 50	
Kingston, Thos. H.		352 00	
Kirton, Wm.		390 50	
Kirtin, N.		516 00	
Kitchen, J.		341 00	
Kitchen, J.		393 25	
Kitcheban, J.		225 50	
Knott, J.		348 25	
Knox, D.		451 50	
Kowaskie, Chas.		41 00	
Krock, A.		390 50	
Labby, F.		55 00	
Labby, J.		85 25	
Labelle, D.		195 25	
Labelle, S.		382 25	
Labine, E.		250 25	
Labine, J.		341 00	
LaBrash, James		385 00	
Labree, P.		140 25	
Lacell, L.		379 50	
Lecleir, P.		192 00	
Lacleir, R.		192 00	
Lacroix, J.		204 00	
Lafond, J.		140 25	
Lafontain, J. D.		401 50	
Carried forward		196,021 96	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	196,021 96	195,824 64
FIRE RANGING.—*Continued.*			
LaGrow, Geo.	....	330 00	
Laidlaw, H.	....	313 50	
Lamey, Jos.	....	250 25	
Lamontague, P.	....	165 00	
Lamonrieux, A.	....	360 25	
Lance, F.	....	387 75	
Langford, T.	....	376 75	
Lanktree, J.	....	437 25	
Laplant, P.	....	379 50	
Laplonte, John	....	321 75	
Lapierre, P.	....	143 00	
Lapuline, J. J.	....	378 25	
Larwell, O.	....	401 50	
Laroque, J.	....	220 00	
Larson, C. G.	....	211 75	
Lascelle, Ed.	....	363 00	
Latour, L.	....	188 50	
Laturski, G.	....	250 25	
Laundry, P.	....	365 75	
Laundry, J.	....	360 25	
Laundry, D.	652 75		
Disbursements	285 40		
		938 15	
Lavalley, W.	....	337 00	
Lavigne, A.	....	363 00	
Lavesque, J.	....	398 75	
Lawrance, S.	....	420 75	
Lawson, Jas.	....	385 00	
Leach, R. H.	....	319 00	
Leamy, J.	....	85 25	
Leberge, J.	679 00		
Disbursements	368 45		
		1,047 45	
Leblance, O.	588 00		
Disbursements	166 52		
		754 52	
Leblanc, Wm.	....	341 00	
Leblanc, Walter	....	379 50	
Leblanc, J.	....	363 00	
LeClair, H.	....	330 00	
Lee, J. B.	795 00		
Disbursements	143 21		
		938 21	
Lee, C.	....	119 90	
Lee, T. F.	....	269 50	
Lefive, F.	....	393 25	
Legarie, A.	....	57 75	
Legris, J. .... Disbursement	....	2,344 00	
Legris, H. M.	....	407 00	
Legris, Thos.	....	407 00	
Lepenskie, Paul	....	393 25	
Leroy, Wm.	....	321 00	
Leroy, L.	825 00		
Disbursements	563 56		
		1,388 56	
Lerwill, R.	....	434 50	
Letourneau, E.	....	294 25	
Lewis, W. H. .... Searches	....	26 05	
Liddicott, T.	....	17 50	
Carried forward	....	216,500 30	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		216,500 30	195,824 64
FIRE RANGING.—*Continued.*			
Lidstone, J.		393 25	
Lipsett, Wm.		211 75	
Livingstone, J.		5 50	
Loney, John		401 50	
Lorimer, Jos.		55 00	
Loughlin, John		324 50	
Lovering, J. E.		379 50	
Ludgate, John		357 50	
Lumb, John		387 75	
Luty, John		129 25	
Lyons, R. B.		363 00	
Lyons, H.		343 75	
MacCrindle, I.		349 02	
Machimitay, J.		203 50	
MacLeod, R.		280 50	
MacMillan, D. H.		5 50	
Madon, J. B.		343 75	
Maloy, T.		420 75	
Malowney, W. H.		376 75	
Mann, J.		367 00	
Mann, R. A.	280 00		
Disbursements	127 75		
		407 75	
Manawasin, P.		385 00	
Manioque, M.		396 00	
Marceau, P.		379 50	
Marchand, L.		291 50	
Martin, E.		253 00	
Martin, R.		378 25	
Martin, S.		378 25	
Martin, T.		387 75	
Mason, Geo.		341 00	
Matchener, Wm.		324 50	
Matheson, R.		379 50	
Matt, A.		12 00	
May, H.	830 00		
Disbursements	1,661 65		
		2,491 65	
Meagher, Geo.		397 75	
Mebes, A.		374 00	
Menard, E.		85 25	
Menard, H.		393 25	
Merchant, John		192 50	
Merkley, J. C.		41 00	
Michie, A.		379 50	
Micholson, J.		189 75	
Middlebrook, J. N.		393 25	
Miller, James		48 85	
Milway, J. H.	957 00		
Disbursements	1,549 39		
		2,506 39	
Misservier, T.		379 50	
Mitchell, P.		418 00	
Moffatt, Jos.		393 25	
Moir, Alex.		382 25	
Molyneaux, Geo.		400 00	
Mongose, A.		250 25	
Montgomery, R.		217 00	
Montgomery, S.		30 25	
Carried forward		236,476 86	195,824 64

Appendix No. 6.—*Continued.*

Service.	$ c.	$ c.	$ c.
Brought forward		236,476 86	195,824 64
Fire Ranging.—*Continued.*			
Montreuil, E.		360 25	
Montreuil, J. J.		365 75	
Montreuil, L.		379 50	
Moody, H. C.		275 00	
Moore, J. V.		434 50	
Moore, P.		74 25	
Moore, A.		196 25	
Moore, W.		337 00	
Morgan, Geo.	580 00		
Disbursements	93 00		
		673 00	
Morin, J.		376 75	
Morin, Jos.		327 25	
Morin, J. E.		390 50	
Morin, D,		129 25	
Morin, L.		151 25	
Mosseau, T.		242 00	
Mosseau, G.		115 50	
Mullette, S.		346 50	
Mullin, D. R.		382 25	
Mullin, A. E.		63 00	
Mullin, J.		6 00	
Muggaberry, T.		148 50	
Munroe, Wm.		382 25	
Munson, J.		22 50	
Murray, Thos.		434 50	
Musquatish, H.		387 75	
McAdam, Jas.		429 00	
McAra, H.		132 00	
McAulay, W. D.	75 00		
Disbursements	16 75		
		91 75	
McBain, R.		393 25	
McCall, H. E.		387 75	
McCarthy, J.		368 50	
McCaw, Wesley	576 00		
Disbursements	298 51		
		874 51	
McCaw, M.		187 00	
McClure, Wm.		393 25	
McCool, F.		308 00	
McCormick, T.		418 00	
Mc Coy, C. L.		434 50	
McCready, M.		393 50	
McCulloch, T.		332 75	
McCurrah, J.		41 25	
McDonald, A. J.	1,800 63		
Disbursements	491 00		
		2,291 63	
McDonald, H. F.		418 00	
McDonald, J. R.		415 25	
McDonald, T.		619 00	
McDonald, D. R.		378 25	
McDonald, Wm.		63 25	
McDonald, John		379 50	
McDonald, Wm.		370 25	
McDonald, M.		209 00	
McDonald, Howard		376 75	
Carried forward		254,184 00	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		254,184 00	195,824 64
FIRE RANGING.—*Continued.*			
McDonald, Neil		225 50	
McDonell, L. P.		376 75	
McDougall, C.	568 00		
Disbursements	4 80		
		572 80	
McFarland, J.		379 50	
McFarlane, Wm.		376 75	
McGarvey, P.		398 75	
McGhee, Chas.		387 75	
McGown, T.	895 00		
Disbursements	1,375 57		
		2,270 57	
McGregor, W. H.	865 00		
Disbursements	630 83		
		1,495 83	
McGregor, J. A.		382 25	
McKechnie, J. A.	970 00		
Disbursements	2,782 54		
		3,752 54	
McKendry, W. B.		379 50	
McKee, T.		379 50	
McKee, T. E.		379 50	
McKenna, P.		310 75	
McKenzie, J.		393 25	
McKenzie, R.		363 00	
McKibbon, J. W.		382 50	
McKinley, J. W.		595 00	
McKinley, A.		299 75	
McKinnon, Thos.		379 50	
McKnight, H.		85 25	
McLaren, J.		412 50	
McLean, C. O.	716 00		
Disbursements	48 55		
		764 55	
McLean, Jas.		444 50	
McLean, Donald		18 00	
McLellan, A.		126 50	
McLellan, B.		341 00	
McLeod, B.		362 00	
McLeod, P.		362 00	
McLeod, J.		319 00	
McLeod, J.		568 00	
McMahon, A.		407 00	
McNally, B.		631 50	
McNee, E.		389 50	
McNee, Geo.		389 50	
McNeill, J. A.		379 50	
McPhail, L. L.		126 50	
McPhee and Gardiner		6 00	
McPherson, J.		49 50	
McQuan, C. R.		310 75	
McSorley, W. J.		222 75	
Nadeau, G.		270 00	
Nairn, A. T.		85 25	
Neegan, J.		121 00	
Neep, P.		382 25	
Neill, J.		437 25	
Nelson, A.		22 50	
Nelson, Nels		412 50	
Carried forward		277,111 79	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		277,111 79	195,824 64
FIRE RANGING.—*Continued.*			
Nevison, W. H. .... Disbursements	608 00		
Disbursements	10 50		
		618 50	
Newman, E.		517 00	
Newman, P.		354 75	
Nicol, Alf.		531 50	
Nicholas, Wm.		379 50	
Nicholson, W.		134 75	
Niddery, R.		242 00	
Noel, A.		213 75	
Nolan, Chas.		385 00	
Norton, W. A.		397 75	
Norris, R.		63 25	
O'Bain, N.		178 75	
O'Brian, D.		376 75	
O'Brien, P.		412 50	
O'Connor, W.		371 25	
Odfeck, J.		401 50	
O'Donnell, J.		376 75	
O Grady, M.		390 50	
O'Grady, E. N.		327 25	
O'Litt, A.		145 00	
O'Neil, F.		375 75	
Oulette, A.		222 75	
Ouellette, A.		374 00	
Packham, C. J.		379 50	
Page, Fred		371 25	
Paquette, John		387 75	
Paquette, Paul		349 25	
Parent, J.		385 75	
Parker, L. H.		346 50	
Parker, A.		404 25	
Parker, C.		195 25	
Parker, S.		173 25	
Parkdale Motors .... Motors		3,915 25	
Parkhurst, J.		387 75	
Passmore, T. A.		294 25	
Pegg, W. R.		291 00	
Pellerine, E.		393 25	
Pellietier, C.		382 25	
Pelotte, J. B.		453 75	
Pellow, C.		335 50	
Penitoche, M.		320 00	
Perrault, E.		420 75	
Peters, Geo.	815 00		
Disbursements	753 44		
		1,568 44	
Peters, J.		305 25	
Peterson, O.		330 00	
Picard, F.		93 50	
Pickering, E.		151 25	
Picott, James		321 75	
Peerce, C.		234 00	
Pierce, Thos.		396 00	
Pierce, Thos.		390 50	
Pierrot, W.		382 25	
Pigeon, C.		390 50	
Pingle, A.		170 50	
Pinnette, Jos.		353 75	
Carried forward		300,174 48	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		300,174 48	195,824 64
FIRE RANGING.—*Continued.*			
Pollock, R.		403 25	
Poole, E. G.	1,675 00		
Disbursements	6,480 16		
		8,155 16	
Porteous, Wm.		379 50	
Post, J. A.		371 25	
Poulin, G.		319 00	
Powell, John		101 75	
Powell, M.		101 75	
Prange, L.		390 50	
Prentice, John		387 75	
Prestley, James		604 00	
Prestley, J.		409 75	
Pritchard, F.		704 00	
Quachazesick, J.		291 50	
Quibell, G.		371 25	
Quinn, Harry		145 75	
Quinn, J. J.		390 50	
Rabbitts, Max	640 00		
Disbursements	236 75		
		876 75	
Raciott, L.		336 25	
Racine, A.		329 00	
Ranson, Fred		365 75	
Redden, M. A.		379 50	
Regan, J. A. M.		401 50	
Reid, C. F.	384 00		
Disbursements	8 65		
		392 65	
Reid, H.		151 25	
Reilly, Wm.		19 25	
Reno, Nels		409 75	
Revell, L. O.	1,122 00		
Disbursements	1,090 46		
		2,212 46	
Reynolds, W. A.		189 00	
Reynolds, W. J.		5 50	
Reynold, J.	580 00		
Disbursements	107 30		
		687 30	
Richard, J.		85 25	
Richard, H.		404 25	
Richmond, W. A.		385 00	
Robb, James		343 75	
Robert, J.		236 50	
Robertson, J. A.		418 00	
Robertson, F.		39 00	
Robillard, A.		345 50	
Robinson, N. J.		11 00	
Robinson, J. B.		408 75	
Robinson, Moses		387 75	
Robinson, Wm.		247 50	
Robinson, S.		10 50	
Robinson, A.		91 00	
Rodgers, W. J.		324 50	
Rolph, Clark, Stone, Limited		618 45	
Rondan, A		134 00	
Ross, A. C.		393 25	
Rowe, James		247 50	
Carried forward		325,588 50	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		325,588 50	195,824 64
FIRE RANGING.—*Continued.*			
Ruddy, E. L. Co., Ltd., Supplies		1,067 61	
Ruddy, Thos.		404 25	
Rudolph, L.		407 00	
Russell, Frank		9 00	
Ryan, W. H.		401 50	
Sadlo, J.		151 25	
Saums, F. E.		187 00	
Saunders, A.		261 25	
Sawdo, M.		85 25	
Sawyer, R.		387 75	
Sawyer, N.		382 25	
Scarlet, Ed.		46 75	
Scott, R.	492 00		
Disbursements	242 12		
		734 12	
Scott, F. A.		372 25	
Scott, F. E.		338 25	
Scott, H.		437 25	
Scythes and Co., Ltd.		153 75	
Sells, P. C.		412 50	
Semmard, E.		401 50	
Sharpe, James		354 75	
Shaw, H.		107 25	
Sheehan, D. J.		275 00	
Sheehan, Dan		379 50	
Sheesheegiven, S.		171 00	
Shields, J.		35 75	
Shields, H.	560 00		
Disbursements	71 45		
		631 45	
Shields, Ed.		6 00	
Sherfield, W. C.		121 00	
Shultz, F.		178 75	
Simmers, J. W.		390 50	
Simpson, M.		393 25	
Sinclair, D.		403 25	
Sing, S.		235 50	
Sing, W. H.	422 00		
Launch	1,200 00		
		1,622 00	
Singleton, J.		143 00	
Skully, Wm.		324 50	
Small, M. A.		115 50	
Smailes, G. R.		348 25	
Smellie, J.		387 75	
Smith, V.		704 00	
Smith, J. D. C.		560 00	
Smith, D.		403 25	
Smith, A.		397 75	
Smith, J. B.		356 00	
Smith, T. D.		382 25	
Smith, D.		348 25	
Smith, J.		253 00	
Smith, John		354 75	
Smith, J. H.		382 25	
Smith, Leslie		393 25	
Smith, Jos.		393 25	
Smith, M.		192 50	
Smyth, John		429 00	
Carried Forward		344,402 43	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		344,402 43	195,824 64
FIRE RANGING.—*Continued.*			
Snaith, W. J.		387 75	
Snyder, F.		379 50	
Sonseise, P.		211 75	
Soulier, W.		379 50	
Spears, W. J.		107 00	
Spence, H.		68 75	
Spillett, J. J.		396 00	
Spilett, P. L.		437 25	
Spreadborough, N.		385 00	
Spreadborough, W.		379 50	
Staniforth, B.		379 50	
St. Lawrence, A.		272 25	
St. Mary, O.		49 50	
Steer, H.		228 25	
Stephens, R. W.		363 00	
Stevenson, J. W.		244 75	
Stewart, W.		209 00	
Stewart, B.		123 75	
Stewart, T.		324 50	
Stewart, J.		382 25	
Stewart, A.		403 25	
Stewart, J. D.		407 00	
Stewart, E. B.		401 50	
Stickanbee, P.		71 50	
Stirling, Alex.		2,878 97	
Stone, Lee		360 25	
Stopes, F.		330 00	
Stover, R.		338 25	
Strange, B.		418 00	
Stratton, R.		404 25	
Stringer, K.		143 00	
Sringer, B.		451 50	
Strutt, A.		88 00	
Sudds, D.		379 50	
Sullivan, M.		365 75	
Sullivan, M.		178 75	
Sutherland, Dave		216 00	
Sutherland, J. W.		431 75	
Swanson, G.		385 00	
Sweeney, L.		233 75	
Sweeney, J.		30 25	
Sword, D.		27 50	
Tabbert, H.		107 25	
Tackney, Thos.	815 00		
Disbursements	547 32		
		1,362 32	
Tait, A.		390 50	
Tait, J.		390 50	
Tallon, M.		297 00	
Tang, J.		376 75	
Tarling, C., Map Co. ... Maps		43 15	
Taylor, S.		85 25	
Taylor, John		308 00	
T. and N. O. Ry. ... Rent		40 00	
Teasdale, J.		170 50	
Tenzies, Wm.		305 25	
Terrien, Geo.		222 75	
Thibb, Elf		430 75	
Thomas, H.		216 00	
Carried forward		363,800 87	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		363,800 87	195,824 64
FIRE RANGING.—*Continued.*			
Thomas, W.		79 75	
Thomson, W. H.		379 50	
Thomson, Fred		409 75	
Thomson, John		412 50	
Thompson, J. W.		195 25	
Thompson, H. B.		156 00	
Tichborne, A.		616 00	
Tomilson, C.		376 75	
Toomer, S.		381 25	
Toutit, John		203 50	
Townsend, W.		52 25	
Townsend, J. E.		318 00	
Tremblay, E.		96 25	
Tremblay, E.		371 25	
Tripp, E. C.	648 00		
Disbursements	229 05		
		877 05	
Trowsse, Alf.	536 00		
Disbursements	213 80		
		749 80	
Tryon, W.		379 50	
Tucker, Wm.		371 25	
Turcott, L.		401 50	
Turcott, J.		348 00	
Turner, J. J. and Sons, Ltd.		821 54	
Tyson, John		379 50	
Urquhart, A.	860 00		
Disbursements	820 34		
		1,680 34	
Valliant, G.		170 50	
Van Dorp, C.		55 00	
Veley, Wm.		167 75	
Velniff, Ed.		387 75	
Vincent, Thos.		327 25	
Visseau, Louis		376 75	
Vollick, C.		101 75	
Walder, W.		16 50	
Walker, Ed.		210 00	
Walker, R.		418 00	
Walker, Geo.		434 50	
Wallingford, M. F.		381 25	
Walmsley, H. H.		173 25	
Walsh, Isaac		379 50	
Ward, D.	640 00		
Disbursements	131 81		
		771 81	
Ward, J.		617 50	
Warner, J. S.		433 50	
Warren, D. L.		73 50	
Watson, Geo.		393 25	
Watters, A. M.		371 25	
Watts, Geo. Rent		90 00	
Waugh, C. A.		332 75	
Weatherill, P.		46 75	
Weiler, C.		420 75	
Weir, Geo.		376 75	
Welsh, Jas.		379 50	
Western Forestry and Conservation Association, Supplies		24 38	
Carried forward		381,788 79	195,824 64

Appendix No. 6.—Continued.

Service.	$ c.		$ c.
Brought forward		381,788 79	195,824 64
FIRE RANGING.—*Concluded.*			
Whims, John	604 00		
Disbursements	76 30		
		680 30	
White, A.		8 25	
White, J.		396 00	
Whitmore, D.		396 00	
Whyte, J. A.		393 25	
Wickens, H.		382 25	
Wilkes, L.		57 75	
Williams, S.		209 00	
Williams, R. N.		110 00	
Wilson, J. H.		371 25	
Wilson, Frank		376 75	
Wilson, James		407 00	
Wilson, H.		79 75	
Wilson, John		387 75	
Wilson, B.		291 50	
Wilson, D.	850 00		
Disbursements	1,170 94		
		2,020 94	
Wisted, J.		167 75	
Witherspoon, J.		63 25	
Witzel, W. J.		319 00	
Wood, J. E.		396 00	
Woodcock, Geo.	584 00		
Disbursements	65 35		
		649 35	
Woods, Wm.		390 50	
Woods, T. J.	930 00		
Disbursements	802 92		
		1,732 92	
Wright, J. S.		376 75	
Wright, C.		352 00	
Wright, Wm.		110 00	
Wright, E.		354 75	
Wynne, P.		420 75	
Youmans, A.		354 75	
Young, John		346 50	
Young, Wm.		385 00	
Young, M.		9 10	
			394,784 90
FOREST RESERVES, *$394,784.40.*			
Temagami Reserve, $48,009.52.			
Baker, Wm.		398 75	
Baptiste, John		8 25	
Barrett, Thos		510 00	
Becker, O.		299 75	
Bell, John		189 75	
Bernard, B.		192 50	
Black, G.		371 25	
Blackwell, J. J.		165 00	
Blanchett, J.		244 75	
Bonhomme, L.		162 25	
Both, W.		484 25	
Bowland, A.		324 50	
Boyd, W. R.		365 75	
Bracken, R.		393 25	
Carried forward		4,110 00	590,609 54

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		4,110 00	590,609 54
FOREST RESERVES.—*Continued.*			
Temagami Reserve.—Continued.			
Burden, John	840 00		
Disbursements	640 63		
		1,480 63	
Buchill, S. E.		319 00	
Cahill, B.		220 00	
Cameron, W. J.		407 00	
Campbell, J. M.	548 00		
Disbursements	189 05		
		737 05	
Carleton, Geo.		79 75	
Caswell, G.		211 75	
Caswell, E.		159 50	
Champlan, P		63 25	
Chatson, F. C.		418 00	
Clarey, G.		357 50	
Clifford, John		324 50	
Coghill, J. M.	524 00		
Disbursements	99 50		
		623 50	
Conners, L.		246 00	
Connors, Thos.		379 50	
Coombes, W. C.		255 75	
Cooper, T.	1,009 75		
Disbursements	82 90		
		1,092 65	
Cowper, J. W.		354 75	
Crocker, K. J.		393 25	
Daynard, W. B.		154 00	
Desmereau, P.		365 75	
Didier, H.	825 00		
Disbursements	1,154 00		
		1,979 00	
Doherty, W.		198 00	
Downey, F.		228 25	
Ellingsworth, W.		151 25	
Ferris, R. .... Disbursements		20 60	
Freve, A.		349 25	
Gale, W. J.		211 75	
Galer, R. B.		143 00	
Girard, S.		112 75	
Gray, Wm.		71 50	
Grendrod, S.		222 75	
Grenier, J.		66 00	
Guyott, J.		57 75	
Hamilton, H.		225 50	
Harper, T.		390 50	
Harrison, J. W.		958 50	
Hartley, Mark		412 50	
Hartt, I. B.	528 00		
Disbursements	120 55		
		648 55	
Heggarty, L. E.		136 50	
Henry, R.		57 50	
Hindson, C. E.	1,625 00		
Disbursements	1,394 60		
		3,019 60	
Hindson, M.		175 00	
Carried forward		22,589 08	590,609 54

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		22,589 08	590,609 54
FOREST RESERVES.—*Continued.*			
Temagami Reserve—Continued.			
Jacob, S. B.		24 75	
Jadouin, J.		46 75	
Jadouin, E.		46 75	
Jones, F.		225 50	
Kellie, J. D.		357 50	
Kettlewell, D. W.		368 50	
King, R.		93 50	
King, E.		71 50	
King, J.		16 50	
Kingsley, Ben.		173 25	
Lamarche, A.		20 00	
Lamarche, R.		20 00	
Lapierriere, A. P.		291 50	
Laronde, Jos.		280 50	
Laronde, John		280 50	
Lavoie, X.		374 00	
Lindsay, G. C.		382 25	
Little, R.		22 00	
Longeuin, A.		316 25	
Longeuin, L.		184 25	
Loyt, A.		321 75	
Luke, J.		66 00	
Mannly, H.		63 25	
MicMac, S.		16 50	
Mildure, F.		200 75	
Millichamp, T.		107 25	
Minard, A.		110 00	
Moriarity, M.		343 75	
Morin, J.		376 75	
Moore, D.		101 75	
Morrison, J.		355 00	
Murphy, J.		299 75	
Murphy, James		294 25	
McDonald, J. C.		250 25	
McDermott, Alex.		407 00	
McFayden, James	628 00		
Disbursements	176 25		
		804 25	
McGuire, M.		374 00	
McHughen, John		206 25	
McIntyre, James		363 00	
McKechnie, A.		349 25	
McKenzie, T.		302 50	
McKenzie, C.		82 00	
McLean, W.		231 00	
McLeish, W. J.		426 25	
McLeish, Wm.		82 50	
McMahon, P.		205 00	
McMullin, Wm.		297 00	
McNally, Jos.		305 25	
Naveau, James		90 75	
Naveau, Thos.		308 00	
Naveau, R.		167 75	
Obrey, J.		71 50	
Ogden, F.		258 50	
Olsen, T.		68 75	
Ostrander, A. E.		198 00	
Carried forward		34,690 33	590,609 54

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		34,690 33	590,609 54
FOREST RESERVES.—*Continued.*			
Temagami Reserve.—Concluded.			
Pacquette, A.		269 50	
Page, A.		46 75	
Parent, B.		358 25	
Patterson, F. D. N.		115 50	
Perrault, Fred.		275 00	
Perrault, Wm.		277 75	
Petrant, W.		291 50	
Phillips, A. G. R.		244 75	
Pirie, J. B.		382 25	
Plaunt, Noel		305 25	
Puffer, D. S.		308 00	
Purdy, J.		228 25	
Rachine, J.		244 75	
Rastoule, F.		101 75	
Reesor, Geo. O.	576 25		
Disbursements	90 20		
		666 45	
Regan, D.		209 00	
Reilly, John		379 50	
Richardson, R.		379 50	
Ross, J. W.		313 50	
Ross, A.		313 50	
Roy, Thos.		374 00	
Sage, P.		361 75	
Simore, D.		104 50	
Stata, S.		352 00	
Steep, E.		236 50	
Stoner, R.		275 00	
Tongue, S.		308 00	
Tooke, S.		258 50	
Towers, R.		247 50	
Trothier, John		258 50	
Tuef, Wm.		231 00	
Turner, Joseph		349 25	
Tyrell, J. A.		244 75	
Viverais, M.		286 00	
Walker, James		409 75	
White, J.		363 00	
Whitebear, F.		33 00	
Wilcox, E. P.		360 25	
Williams, A.		79 75	
Wilmer, S.		110 00	
Wilson, Alex.		376 75	
Young, R. J.	860 00		
Disbursements	930 74		
		1,790 74	
Young, J.		198 00	
Mississaga Reserve, $24,454.34.			
Abbey, Chas.		253 00	
Acheson, L.	840 00		
Disbursements	1,295 39		
		2,135 39	
Backer, C.		57 75	
Belaney, A.		394 25	
Belledeau, Geo.		55 00	
Carried forward		50,904 91	590,609 54

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		50,904 91	590,609 54
FOREST RESERVES.—*Continued.*			
Mississaga Reserve.—Continued.			
Bennett, H.		228 25	
Boughman, A. M.		324 50	
Buisson, Wm.		376 75	
Cade, H.		178 75	
Carlson, F.		412 50	
Carpenter, R. J.	620 00		
Disbursements	236 35		
		856 35	
Causley, B.		409 75	
Catt, Wm.		44 00	
Champeux, H.		376 75	
Chartrand, T.		385 00	
Checkley, E.		280 50	
Cloute, Geo.		420 75	
Cloutier, H.		341 00	
Collins, N.		396 00	
Cousineau, M.		247 50	
Davidson, R. W.		382 25	
Davidson, R.		382 25	
Desbrian, F.		85 25	
Duval, C. A. ....Disbursements		1,250 00	
Ecker, C. M.		407 00	
Egan, D.		371 25	
Godson, H.	613 75		
Disbursements	136 65		
		750 40	
Gray, E. J.		258 50	
Groulx, E.		261 25	
Hillman, John		283 25	
Howard, Wm.		140 25	
Huckson, A. H. ....Disbursements		5 80	
Hussey, L.		396 00	
Jackpine, S.		110 00	
Jean, A.		620 00	
Jigeur, J.		228 25	
Jones, John		412 50	
Laundry, Alex.		233 75	
Leblanc, Lorne		420 75	
Legacy, F.		390 50	
Leveille, Frank		239 25	
Loosemore, S.		393 25	
Managness, J.		162 25	
Managness, M.		162 25	
Martin, J.		341 00	
Metoogenese, Alex.		165 00	
Michel, John		181 50	
Miller, M.		140 25	
Miller, H.		140 25	
Moss, C.		93 50	
Murray, John		409 75	
McAllister, A. J.		387 75	
McAuley, Alex.		57 75	
McGrath, B.		335 50	
McIlmoyle, W.		409 75	
Nicholas, Herbert	560 00		
Disbursements	225 90		
		785 90	
Carried forward		67,977 36	590,609 54

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		67,977 36	590,609 54
FOREST RESERVES.—*Continued.*			
Mississaga Reserve.—Concluded.			
O'Donnell, James		19 25	
Orange, Wm.		382 25	
Otter, B.		88 00	
Panter, A.		112 75	
Philion, M.		368 50	
Reid, James		409 75	
Ruttledge, J.		283 25	
Sailor, H.		222 75	
Sailor, D.		151 25	
Seeley, S.		371 25	
Shawabik, P.		173 25	
Shawabik, S.		173 25	
Smith, J.		280 50	
Smith, Thos.		178 75	
Snooks, Geo.		49 50	
Spaniel, James		260 25	
St. Laurent, J.		126 00	
Tierney, T.		198 00	
Turner, S.		247 50	
Ugongin, Chas.		126 50	
Valen, L.		55 00	
Valois, A.		151 25	
Vice, L.		57 75	
Nepigon Reserve, $23,457.35.			
Anderalcourt, A.		44 00	
Barker, A.		426 50	
Bouchard, J.		700 50	
Bouchard, M.		266 75	
Bouchard, W.		490 87	
Bouchard, D.		12 37	
Braggan, Wm.		363 00	
Cummins, T. A.	580 00		
Disbursements	1,644 53		
		2,224 53	
DeLaronde, J.		107 25	
Desmoulin, J.		1 37	
Donio, J.		363 00	
Donley, J. P.		387 75	
Erkkila, S.		30 00	
Esquaga, Louis		137 50	
Fitzback, J.		619 50	
Goodchild, Louis		266 75	
Halme, O.		24 00	
Jokila, N.		273 00	
Kerr, D. W.		453 75	
King, S.		291 50	
Lagard, A.		145 75	
Leo, Chas.		110 00	
Lofquist, M.		363 00	
Maki, J.		285 00	
Memo, J.		154 00	
Michael, S.		346 50	
Michael, A.		302 50	
Michael, R.		211 75	
Micholson, J.		586 25	
Carried forward		82,452 50	590,609 54

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		82,452 50	590,609 54
FOREST RESERVES.—*Continued.*			
Nepigon Reserve.—Concluded.			
Micholson, Geo.		253 00	
Moose, P.		134 75	
Moose, Harry		231 00	
Morriseau, Fred.		457 87	
Morriseau, D.		143 00	
McDonald, M. D.		44 00	
McLeod, E. H.	1,135 00		
Disbursements	3,025 74		
		4,160 74	
Nance, Thos.		346 50	
Nemo, A.		151 25	
Netemegesic, F.		365 75	
Nicholson, Chas.		129 25	
Odawa, J.		470 25	
Ojitimo, S.		365 75	
Oskopeda, J.		363 00	
Perkins, A. J.		823 50	
Poile, J.		253 00	
Poile, T.		451 00	
Poile, John		363 00	
Robinson, Peter		137 50	
Robinson, A.		145 75	
Shabawaykesick, A.		200 75	
Sponge, Wm.		363 00	
Thomson, J. G.		612 00	
Thomson, J.		143 00	
Thompson, Joseph		24 75	
Torrance, E. A.		379 50	
Walker, H.		382 25	
Ward, James		393 25	
Willan, Wm.	739 25		
Disbursements	6 60		
		745 85	
Young, J. J.		434 50	
Eastern Reserve, $3,424.13.			
Bander, Wm.		401 50	
Bishop, H.		401 50	
Breen, James		401 50	
Gilmour, Ed.		162 25	
Hughes, Geo.		401 50	
Laundry, A.		401 50	
Lloyd, C.		233 75	
Myers, John		400 00	
Tapping, Thos.	600 00		
Disbursements	20 63		
		620 63	
Sibley Reserve, $100.00.			
Oliver, J. A.		100 00	
			99,445 34
CULLERS' ACT.			
McDougall, J. T. .... Disbursements		6 00	
Green, Wm.	12 00		
Disbursements	3 10		
		15 10	21 10
Carried forward			690,075 98

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward			690,075 98
Reforestration.			
Bell Telephone Company		33 60	
Supplies		2,213 30	
Labor		5,903 57	
Sundries		544 13	
			8,694 60
Mines and Mining.			
Miller, W. G., Provincial Geologist, services	5,000 00		
Disbursements	226 76		
		5,226 76	
Knight, C. D., 1st Assistant Geologist, services	2,500 00		
Disbursements	1,465 74		
		3,965 74	
Burrows, A. G., 2nd Assistant Geologist, services	2,350 00		
Disbursements	610 85		
		2,960 85	
Hopkins, P. E., 3rd Assistant Geologist, services	1,900 00		
Disbursements	1,575 06		
		3,475 06	
Rogers, W. R., Topographer, services	2,000 00		
Disbursements	64 24		
		2,064 24	
Bell, W. J., Cartographer, services		1,700 00	
Mickle, G. R., Mine Assessor, services	4,200 00		
Disbursements	303 82		
		4,503 82	
Godson, T. E., Mining Commissioner, services	4,500 00		
Morris, W. H., Mining Commissioner's Clerk services	1,700 00		
White, Miss N., Stenographer	772 17		
Disbursements	1,078 10		
		8,050 27	
Sutherland, T. F., Chief Inspector of Mines, services	3,300 00		
Disbursements	1,386 95		
		4,686 95	
Collins, E. A., 1st Assistant Inspector of Mines, services	3,000 00		
Disbursements	1,131 62		
		4,131 62	
McMillan, J. G., 2nd Assistant Inspector of Mines, services		2,270 00	
Bartlett, J., 3rd Assitant Inspector of Mines, services		2,270 00	
Stovel, J. H., 4th Assistant Inspector of Mines, services, for four months. Resigned	1,000 00		
Disbursements	320 67		
		1,320 67	
Webster, A. R., 4th Assistant Inspector of Mines, services, for five months	1,250 00		
Disbursements	434 50		
		1,684 50	
Jackson, P. A., Surveyor, services		1,500 00	
McArthur, T. A., Inspector of Recorders' Offices, services	800 00		
Disbursements	466 40	1,266 40	
Carried forward		51,076 88	698,770 58

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward		51,076 88	698,770 58
MINES AND MINING.—*Concluded.*			
Beno, J. W., services	659 29		
Disbursements	447 46		
		1,106 75	
Clarke, C. J. Disbursements		14 20	
Crompton, R. B., services		120 00	
Davidson, John F., services		60 00	
Drury, Prof. C. W., services		150 00	
Estlin, E. S., services	2,042 31		
Disbursements	1,127 38		
		3,169 69	
Easton, M., services		94 23	
Kerr-Lawson, D. E., services		70 00	
Ledoux, Prof. A., services	484 61		
Disbursements	539 58		
		1,024 19	
McKechnie, A. B., services		70 00	
Near, A. E., services	859 29		
Disbursements	158 10		
		1,017 39	
Parsons, Prof. A. L., services	502 31		
Disbursements	598 60		
		1,100 91	
Scott, John, services	859 29		
Disbursements	304 65		
		1,163 94	
King's Printer		448 76	
Express		12 70	
Telegraphing		64 05	
Typewriter repairs, etc.		16 00	
Sundries		23 03	
			60,802 72
RESEARCH WORK.			
Clarke, A. L., services			1,166 00
MINING RECORDERS.			
Browning, A. J., Recorder	600 00		
Morgan, M. R., Assistant	83 00		
Loudon, W. E., Clerk	492 31		
Boyer, P. H., Clerk	75 00		
Disbursements	275 83		
		1,526 14	
Campbell, C. A., Recorder	1,138 41		
Shanahan, Miss M., Stenographer	362 70		
Disbursements	349 75		
		1,850 86	
Gauthier, G. H., Recorder	1,500 00		
O'Brien, J. D., Clerk	1,120 00		
Loudon, W. E., Clerk	134 62		
Disbursements	881 38		
		3,636 00	
Hough, J. A., Recorder	1,400 00		
Ginn, H. G., Clerk	1,074 65		
Loudon, W. E., Clerk	376 92		
Stewart, Miss H., Stenographer	380 00		
Disbursements	399 21		
		3,630 78	
Carried forward		10,643 78	760,739 30

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward	....	10,643 78	760,739 30
MINING RECORDERS.—*Concluded.*			
Miller, N., Recorder	1,100 00		
Disbursements	331 25		
		1,431 25	
Morgan, M. R., Recorder	583 00		
Disbursements	407 50		
		990 50	
Morgan, J. W., Recorder	1,098 00		
Disbursements	433 20		
		1,531 20	
McAulay, N. J., Recorder	1,900 00		
Sarsfield, J. M., Clerk	1,300 00		
Loudon, W. E., Clerk	138 46		
Munro, Miss E., Stenographer	780 00		
Disbursements	806 85		
		4,925 31	
McQuire, H. F., Recorder	500 00		
Disbursements	152 58		
		652 58	
Sheppard, H. E., Recorder	854 68		
Morgan, M. R., Assistant	167 00		
Loudon, W. E., Clerk	61 54		
Disbursements	148 01		
		1,231 23	
Spry, W. L., Recorder	900 00		
Disbursements	116 10		
		1,016 10	
Express	68 65		
King's Printer	1,120 02		
Telegraphing	20 33		
		1,209 00	
PROVINCIAL ASSAY OFFICE.			23,630 95
Leat, Arthur	....	529 35	
McNeill, W. K.	2,200 00		
Disbursements	63 40		
		2,263 40	
Rothwell, T. E.	1,574 00		
Disbursements	144 30		
		1,718 30	
Supplies	1,179 25		
Disbursements	233 22		
		1,412 47	
MINERAL DISPLAY AT EXHIBITIONS.			5,923 52
Clark, James, Services *re* Toronto Exhibition	....	77 00	
West, W. J., Services *re* Toronto Exhibition	....	57 00	
General Disbursements *re* Exhibitions	....	1,628 63	
			1,762 63
EXPERIMENTAL TREATMENT OF ORES	....	....	759 73
MINING COMMISSIONER'S JUDGEMENTS	....	....	275 00
SOCIETY MEMBERSHIP FEES	....	....	191 90
ANNUAL MEMBERSHIP FEES	....	....	35 75
SURVEYS	....	....	40,827 29
Carried forward			834,146 07

Appendix No. 6.—Continued.

Service.	$ c.	$ c.	$ c.
Brought forward			834,146 07
Board of Subveyors			200 00
Investigation of Tree Diseases			5,410 53
Insurance			1,234 98
Allowance to School Section in Township of South Walsingham			150 00
Canadian Forestry Association, Grant			300 00
Refunds—Miscellaneous			25,561 54
Colonization and Immigration.			
Printing, Advertising, etc.		13,085 32	
Land Guides		116 00	
Emigration Work in Great Britain		23,930 73	
Allowance to Richard Reid and J. M. Clark		3,112 00	
Rental Immigration Office		1,473 39	
			41,717 44
Contingencies.			
Departmental.			
Printing and Binding	1,551 83		
Stationery	5,398 60		
		6,950 43	
Postage	1,524 90		
Express	186 23		
		1,711 13	
Telegraphing	529 91		
Car Fare	40 00		
		569 91	
Subscriptions	252 40		
Advertising	12,303 02		
		12,555 42	
Typewriters, repairs, etc.		1,451 97	
Cain, W. C., travelling expenses	25 00		
Draper, S., travelling expenses	144 90		
Ferguson, Hon. G. H., travelling expenses	900 00		
Grigg, A., travelling expenses	4 55		
Hele, C. C., travelling expenses	125 95		
Hutcheon, J., travelling expenses	589 85		
Niven, F. J., travelling expenses	47 70		
Robbins, H. M., travelling expenses	40 55		
Rorke, L. V., travelling expenses	173 45		
Work, J., travelling expenses	71 15		
		2,123 10	
Extra Clerks	9,234 05		
Maps	4,668 85		
Sundries	682 28		
		14,585 18	
			39,947 14
Carried forward			948,667 70

Appendix No. 6.—Concluded.

Service.	$ c.	$ c.	$ c.
Brought forward	....	....	948,667 70
CONTINGENCIES.—*Concluded.*			
Bureau of Mines.			
Printing and Binding	2,899 03		
Stationery	2,840 47		
		5,739 50	
Postage	853 89		
Telegraphing	70 11		
Express and Cartage	28 68		
Advertising	1,475 33		
Subscriptions	430 32		
Maps	1,267 21		
		4,125 54	
Typewriters, repairs, etc.	221 45		
Gibson, T. W., travelling expenses	102 47		
Van der Voort, A., Searching Titles	359 50		
		683 42	
Extra Clerks	1,995 17		
Sundries	110 22		
		2,105 39	
			12 653 85
Forestry.			
Zavitz, E. J., travelling expenses	....	228 64	
Postage	389 32		
Typewriters, repairs, etc.	167 92		
Extra Clerks	1,176 00		
Supplies	1,047 23		
Sundries	212 69		
		2,993 16	
Colonization.			3,221 80
Printing and Binding	8 02		
Stationery	268 64		
		276 66	
Postage	150 58		
Express	74 59		
		225 17	
Telegraphing	113 38		
Subscriptions	48 50		
Typewriters, repairs, etc.	114 50		
		276 38	
Jones, R. A., travelling expenses	62 80		
Macdonell, H. A., travelling expenses	89 87		
Tutt, H., travelling expenses	19 45		
Sundries	122 05		
		294 17	
			1,072 38
			965,615 73

D. GEO. ROSS,
Accountant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 7.

Statement of expenses on account of various services under the direction of the Department of Lands, Forests and Mines for the year ending October 31st, 1918.

Service.	$ c.	$ c.
Algonquin Provincial Park	29,716 95	
Algonquin Provincial Park, Cleaning Right-of-Way	149 08	
		29,866 03
Quetico Provincial Park		9,424 20
Fuel Investigation		54,322 80
Veterans' Commutation		150 00
Royal Nickel Commission		10,182 05
Legal Investigations		1,285 00
Bounty Act, Edward VII, Cap. 14.		
Deloro Mining and Reduction Co.	19,284 26	
Coniagas Reduction Co., Ltd.	21,345 63	
Metals Chemical Co., Ltd.	12,689 71	
Canadian Smelting and Refining Co.	1,707 89	
		55,027 49
		160,257 57

D. GEO. ROSS,
Accountant.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 8.

PATENTS OFFICE (LANDS BRANCH).

Statement of Patents, etc., issued from 1st November, 1917, to 31st October, 1918.

Public Lands (late Crown)	390
" " (late School)	35
" " (late Clergy Reserves)	6
" " (University)	13
Free Grant Lands (Act of 1913)	297
" " " (Act of 1901) (Veterans)	115
Mining Lands (Patents)	337
Mining Leases	68
Crown Leases	20
Licenses of Occupation	50
Timagami Island Leases	2
Sand and Gravel Licenses	18
Total	1,351

CHARLES S. JONES,
Patents Clerk.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

W. C. CAIN,
Chief Clerk in Charge.

Appendix

WOODS AND

Statement of Timber and Amounts accrued from Timber Dues, Ground

QUANTITY AND

Agencies.	Area covered by timber licenses.	Saw logs.				Boom and	
		Pine.		Other.		Pine.	
	Square miles.	Pieces	Feet B.M.	Pieces.	Feet B.M.	Pieces.	Feet B.M.
Western Timber District	12,198	5,095,221	197,181,151	654,582	18,268,281	49,542	5,873,261
Belleville Timber District	693	51,520	1,039,634	68,300	2,060,862	267	28.829
Ottawa Timber District	3,997	311,827	18,691,395	238,052	7,273,194	3,553	409,558
	16,888	5,458,568	216,912,180	960,934	27,602,337	53,362	6,311 648

General Statement

Agencies.	Posts.	Poles.	Bolts.	Pulpwood	Pine.			
	Pieces.	Pieces.	Cords.	Cords.	Pieces.	Cubic Feet.	Transfer bonus.	Interest.
							$ c.	$ c.
Western Timber District	25,990	1,382	1,816	315,140	1,452	78,874	3,495 00	15,678 03
Belleville Timber District	3,419	....	....	1,899	....	....	85 00	125 27
Ottawa Timber District	294	835	....	21,524	....	....	1,160 00	365 59
	29,703	2,217	1,816	338,563	1,452	78,874	4,740 00	16,168 89

JOHN HOUSER,
Chief Clerk in Charge.

No. 9.

FORESTS.

Rent and Bonus during the year ending 31st October, 1918.

DESCRIPTION OF TIMBER.

Dimension.		Cedar.	Piling.			Cordwood.		Tan Bark.	Railway Ties.
Other.						Hard.	Soft.		
Pieces.	Feet B.M.	Lineal feet.	Lineal feet.	Pieces	Feet B.M.	Cords.	Cords.	Cords.	
10,424	992,625	3,436	125,402	1,090	116,627	32,442	24,520	2,410	2,088,935
1,355	259,661	....	....	......	....	746	22	347	3,500
4,030	514,150	....	....	......	....	63	4,022	870	1,664
15,809	1,766,436	3,436	125,402	1,090	116,627	33,251	28,564	3,627	2,094,099

of Timber.—Concluded.

Amounts accrued.

Trespass.	Timber dues.	Bonus.	Deposits timber sales.	Ground rent.	Fire protection.	Total.
$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
30,759 80	673,427 12	468,038 88	118,450 00	62,005 00	159,436 87	1,531,290 70
789 45	4,421 57	683 54	....	5,277 00	4,217 60	15,599 43
374 16	40,835 95	....	....	19,940 00	26,118 60	88,794 30
31,923 41	718,684 64	468,722 42	118,450 00	87,222 00	189,773 07	1,635,684 43

ALBERT GRIGG,
Deputy Minister.

Appendix No. 10.

WOODS AND FORESTS BRANCH.

Statement of Revenue collected during the year ending October 31st, 1918.

Amount of Western collections at Department	$1,653,014 58
do Belleville collections at Department	15,020 37
do Ottawa collections at Department	88,050 30
	$1,756,085 25

WOODS AND FORESTS.

Bonus	$679,304 17
Timber dues	795,004 08
Ground rent	87,263 93
Transfer fees	4,740 00
Fire protection	189,773 07
	$1,756,085 25

WOODS AND FORESTS BRANCH REVENUE.

October 31st, 1918.

Western District—		
Timber dues	$738,704 43	
Bonus	560,245 25	
Ground rent	62,005 00	
Interest on dues	15,675 33	
Interest on ground rent	2 70	
Transfer fees	3,495 00	
Timber sale deposits	118,450 00	
Fire protection	159,436 87	
		$1,653,014 58
Ottawa District—		
Timber dues	$40,466 11	
Ground rent	19,940 00	
Interest on dues	327 16	
Interest on ground rent	38 43	
Transfer fees	1,160 00	
Fire protection	26,118 60	
		88,050 30
Belleville District—		
Timber dues	$4,706 58	
Bonus	608 92	
Ground rent	5,277 00	
Interest on dues	124 47	
Interest on ground rent	0 80	
Transfer fees	85 00	
Fire protection	4,217 60	
		15,020 37
		$1,756,085 25

JOHN HOUSER,
Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister,

Appendix No. 11.

Statement of work done in the Military Office, Lands Branch of the Department of Lands, Forests and Mines, during the year ending October 31st, 1918.

Reference for Veterans' Patents issued	115
Locations under military certificates	23
Certificates applied in payment of lands	11
Certificates surrendered for commutation money	3
Letters received	1,650
Letters written	1,920
Special letters to agents	240
Special letters to mining recorders	92
Maps and reports supplied to veterans	280
Printed forms sent out	320
Copies of Veteran Act supplied	18

H. E. JOHNSTON,
Military Clerk.
W. C. CAIN,
Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister,

Appendix No. 12.

Memorandum of parties who passed the Cullers' Examination of 1918.

Rabbitts, Malcolm, 91 Winnipeg Ave., Port Arthur, Ont., examined at Kenora, August 28th, 1918, licensed October 1st, 1918.

Street, John Royden, c/o Jas. Stewart, Port Arthur, Ont., examined at Kenora, August 28th, 1918, licensed October 1st, 1918.

Appendix No. 13.

RECORDS BRANCH, 1917-18.

Communications Received:

From Crown Lands Agents		5,910
" Mining Recorders		2,883
" Crown Timber Agents		4,408
" Homestead Inspectors		1,320
" Superintendent Algonquin Park		496
" Superintendent, Quetico Park		123
Orders-in-Council		153
Telegrams		282
Soldiers and Sailors (letters)		660
Nickel Commission	(Figures supplied by them)	1,500
Northern Development Branch	" " "	8,203
Colonization Branch	" " "	5,008
Loan Commissioner	" " "	2,978
Mining Commissioner	" " "	2,989
Forestry Branch	" " "	4,782
Mine Assessor	" " "	1,865
Mine Inspector	" " "	1,712
Provincial Geologist	" " "	404
All other sources	" " "	29,151
Total incoming (Minister's office not included)		74,827

Communications Sent Out:

To Crown Agents, Inspectors, Rangers and Park Superintendents		17,800
To General Public		20,614
Circular letters (timber sales)		1,790
Maps and blue prints		2,898
Mining Reports to foreign countries		520
Mining Reports to United States and other countries		145
Mining Acts		1,400
Nickel Commission (letters)	(Figures supplied by them)	1,000
Nickel Commission (reports)	" " "	850
Northern Development Branch (letters)	" " "	6,202
Northern Development Branch (seed grain)	" " "	1,348
Colonization Branch (letters)	" " "	4,147
Colonization Branch (Northern Ontario literature)	" " "	17,656
Colonization Branch (Ontario maps)	" " "	1,236
Loan Commissioner	" " "	5,316
Mining Commissioner (letters)	" " "	6,033
Mining Commissioner (orders)	" " "	799
Forestry Branch (letters)	" " "	7,584
Forestry Branch (circulars)	" " "	2,250
Forestry Branch (parcels by post)	" " "	450
Mine Assessor	" " "	1,865
Mine Inspector	" " "	1,211
Provincial Geologist	" " "	382
Total outgoing (Minister's office not included)		103,496

Postage:

Postage for the year, Records Branch	$2,819 38
" " " Colonization Branch	113 62
" " " Loan Commissioner	150 68
" " " Forestry Branch	380 00

Files:

New files issued, general	5,363
" " " accounts chargeable	511
" " " accounts free	193

ALBERT GRIGG,
Deputy Minister.

S. K. BURDIN,
Chief Clerk, Records Branch.

Appendix No. 14.

Statement showing the number of Locatees and of acres located; of purchasers and of acres sold; of lots resumed for non-performance of the settlement duties and of patents issued in Free Grant Townships during the year ending 31st October, 1918.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Baxter	Muskoka	J. B. Brown, Bracebridge	1	153	2	19¾	8	838	6	438
Brunel	"	"	1	99	....	....	1	99	1	100
Cardwell	"	" "	3	568	....	....	3	568	1	198½
Chaffey	"	" "	1	100	....	....	1	100	1	101
Draper	"	" "	....	....	....	....	....	....	1	111
Franklin	"	" "	....	....	....	....	....	....	2	100½
Freeman	"	" "	1	200	....	....	1	200	4	789½
Macaulay	"	" "	2	167	....	....	2	167	....	....
Medora	"	" "	1	100	....	....	1	100	1	159
Monck	"	" "	....	....	....	....	....	....	....	....
Morrison	"	" "	3	431	1	5	....	....	....	....
Muskoka	"	" "	1	97	....	....	2	247	2	105
McLean	"	" "	1	101	....	....	2	202	....	....
Oakley	"	" "	....	....	....	....	1	201	1	100
Ridout	"	" "	....	....	....	....	....	....	....	....
Ryde	"	" "	2	214	....	....	2	214	1	121
Sherborne	"	" "	1	76	....	....	1	76	....	....
Sinclair	"	" "	7	1,193	4	128	12	1,253	8	1,114
Stephenson	"	" "	....	....	....	....	....	....	....	....
Stisted	"	" "	2	204	1	100	2	204	1	100
Watt	"	" "	....	....	....	....	....	....	1	6½
Wood	"	" "	2	402½	....	....	7	966	2	344
Blair	Parry Sound	Miss I. M. Campbell, Parry Sound	....	....	1	5	....	....	....	....
Burpee	"	"	1	200	....	....	2	300	1	200
Carling	"	" "	3	500	....	....	2	400	2	300
Christie	"	" "	6	763	1	50	4	566	....	....
Conger	"	" "	2	348	....	....	4	627	7	695
Cowper	"	" "	....	....	....	....	....	....	4	.11
Foley	"	" "	....	....	....	....	....	....	....	....
Ferguson	"	" "	1	100	....	....	1	100	....	....
Hagerman	"	" "	....	....	....	....	....	....	1	217
Harrison	"	" "	....	....	1	5	....	....	7	25
Henvey	"	" "	6	769	....	....	....	....	1	111¼
Humphrey	"	" "	....	....	....	....	....	....	....	....
McConkey	"	" "	....	....	....	....	....	....	1	94
McDougall	"	" "	1	178	....	....	1	91	3	400
McKellar	"	" "	....	....	....	....	....	....	2	200
McKenzie	"	" "	....	....	....	....	....	....	2	180
Monteith	"	" "	2	299	....	....	1	200	4	679
Shawanaga	"	" "	....	....	....	....	....	....	1	½
Wilson	"	" "	....	....	....	....	....	....	2	171¾
Chapman	Parry Sound	Dr. J. S. Freeborn, Magnetawan	5	532	....	....	6	652	4	576
Croft	"	"	1	100	....	....	1	100	2	370
Ferrie	"	" "	....	....	....	....	....	....	....	....
Gurd	"	" "	....	....	....	....	....	....	2	400
Lount	"	" "	1	31	2	94	1	31	2	128
Machar	"	" "	5	597	1	87	9	1,292	2	300
Mills	"	" "	1	138	....	....	....	....	1	100
Pringle	"	" "	....	....	....	....	....	....	4	800

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Ryerson......	Parry Sound..	Dr. J. S. Freeborn, Magnetawan	....	....	...	......	....	....	4	715
Spence	"	" "	2	199	...	......	1	100	2	199
Strong	"	" "	1	100	...	......	1	100	....	....
Armour......	Parry Sound..	W. Jenkin, Emsdale..	2	193	...	......	2	193	2	305
Bethune	"	" "	....	....	...	......	3	501	....	....
Joly	"	" "	3	579	1	1	4	670	2	301
McMurrich ...	"	" "	....	....	...	......	....	....	1	96
Perry	"	" "	....	....	...	......	....	....	2	184
Proudfoot	"	" "	....	....	1	2	3	349	4	446
Hardy	Parry Sound..	H. J. Ellis, Powassan.	....	....	...	......	....	....	1	100
Himsworth ..	"	" "	6	815	2	118	5	609	1	123
Laurier......	"	" "	....	....	...	......	1	118	1	100
Nipissing	"	" "	4	500	...	......	3	276	1	100
Patterson....	"	" "	1	190	1	2	1	190	1	2½
Bonfield.....	Nipissing	W. J. Parsons, North	10	1,329	...	......	9	900	10	1,800
Boulter	"	" " Bay	1	102	...	......	....	....	2	236
Chisholm	"	" "	8	1,075	...	......	6	712	4	400
Ferris	"	" "	6	799	...	......	4	499	9	1,120
Anson	Haliburton ...	R. H. Baker, Minden..	....	....	...	......	....	....	2	202
Glamorgan ..	"	" "	5	634½	2	115½	2	289	3	197
Hindon	"	" "	....	....	1	75½	....	....	....	....
Lutterworth..	"	" "	....	....	...	......	4	403	....	445
Minden	"	" "	3	270½	...	......	2	195	3	200
Snowdon	"	" "	....	....	...	......	2	291	2	377½
Stanhope.....	"	" "	1	90	1	45	1	90	4	....
Anstruther ...	Peterborough.	William Hales, Apsley	....	....	...	......	1	98	....	....
Burleigh, N.D.	"	" "	1	100	...	......	....	....	1	54
" S.D.	"	" "	....	....	...	......	....	....	....	....
Chandos	"	" "	....	....	...	......	....	....	....	....
Methuen	"	" "	....	....	...	......	3	300	....	....
Cardiff.......	Haliburton ...	A. N. Wilson, Kinmount	2	181	...	......	5	500	3	452½
Cavendish....	Peterborough.	" "	3	263	...	......	1	100	1	8
Galway	"	" "	2	200	...	......	4	519	1	222
Monmouth ...	Haliburton ...	" "	4	562	...	......	4	487	3	468
Bangor	Hastings	W. J. Douglas, May-	3	345	...	......	3	346	2	84
Carlow.......	"	" "nooth	1	100	2	159	10	1,279	4	519
Cashel	"	" "	....	....	...	......	....	....	....	....
Dungannon ..	"	" "	2	288	1	82	1	100	4	706
Faraday	"	" "	2	312	...	......	3	412	1	252
Herschel	"	" "	1	100	...	......	....	....	1	229
Limerick.....	"	" "	....	....	...	......	....	....	2	150
Mayo	"	" "	1	100	...	......	1	100	2	257½
Monteagle ...	"	" "	1	100	...	......	....	....	2	181
McClure	"	" "	1	98	...	......	....	....	3	459
Wicklow	"	" "	5	550	1	5	....	....	1	200
Wollaston....	"	" "	....	....	1	9	....	....	1	209
Algona, S.....	Renfrew......	Adam Prince, Wilno...	1	100	...	......	....	....	....	....
Brougham ...	"	" "	....	....	...	......	....	....	....	....
Brudenell ...	"	" "	....	....	...	......	....	....	1	82
Burns	"	" "	....	....	1	99	....	....	....	....

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Grattan	Renfrew	Adam Prince, Wilno...	....	....	...	......	....	....	3	300
Griffith	"	" "	....	....	...	......	....	....	....	....
Hagarty	"	" "	3	251	1	22	....	....	4	372
Jones	"	" "	....	....	...	......	....	....	....	....
Lyell	"	" "	3	410	...	......	....	....	1	185
Lyndoch	"	" "	....	....	...	......	....	....	....	....
Matawatchan.	"	" "	2	200	...	......	....	....	1	189
Radcliffe	"	" "	....	....	...	......	....	....	....	....
Raglan	"	" "	1	100	...	......	....	....	4	400
Richards	"	" "	1	94	...	......	....	....	1	92½
Sebastopol ..	"	" "	1	140	...	......	....	....	1	80
Sherwood	"	" "	....	....	...	......	....	....	1	100
Algona, N....	Renfrew	Finlay Watt, Pembroke	1	45	...	......	....	....	....	....
Alice	"	" "	....	....	...	......	1	200	2	173
Buchanan	"	" "	....	....	...	......	....	....	....	....
Clara.........	"	" "	1	204	1	64	....	....	1	64
Fraser	"	" "	4	381	...	......	....	....	1	100
Head	"	" "	1	100	...	......	....	....	....	....
Maria	"	" "	....	....	...	......	....	....	....	....
McKay........	"	" "	....	....	...	......	....	....	....	....
Petawawa ...	"	" "	....	....	...	......	....	....	....	....
Rolph	"	" "	1	98	...	......	....	....	....	....
Wilberforce ..	"	" "	....	....	...	......	....	....	....	....
Wylie (pt.) ...	"	" "	3	297	...	......	....	....	....	....
Calvin	Nipissing	Robt. Small, Mattawa	1	100	...	......	1	100	....	....
Cameron (pt.).	"	" "	16	2,003	1	18	2	193	2	218
Lauder	"	" "	1	102	...	......	1	102	....	....
Mattawan....	"	" "	....	....	...	......	....	....	2	197
Papineau	"	" "	4	500	...	......	1	100	2	157
Korah	Algoma.. ...	Edward Noble, Sault	....	....	1	2	....	....	1	162
Parke.........	"	" Ste. Marie	....	....	...	......	....	....	....	....
Prince	"	" "	1	80	...	......	5	638	....	....
Aberdeen	Algoma.......	Thos. Dodds, Thessalon	1	163	...	......	....	....	....	....
" add.	"	" "	....	....	...	......	....	....	....	....
Galbraith	"	" "	....	....	...	......	....	....	1	166½
Lefroy	"	" "	....	....	...	......	....	....	....	....
Plummer	"	" "	....	....	...	......	....	....	....	....
" add.	"	" "	....	....	...	......	....	....	....	....
St. Joseph Is'd	Algoma.......	W. E. Whybourne,	11	1,305	1	18	11	1,305	5	622
St. Joseph Ch'nl Is'd	....	Marksville " "	....	....	...	......	....	....	....	....
Baldwin......	Algoma	Edward Arthurs,	1	161	1	1	1	160	2	317½
Merritt.......	"	" Espanola	1	128	...	......	....	....	....	....
Blake...... ..	Thunder Bay.	W. A. Burrows, Port	....	....	...	......	4	640	1	160
Conmee	"	" Arthur	4	426¾	6	241¾	2	239¼	13	1,043
Crooks	"	" "	1	160	...	......	11	1,616	3	485½
Dawson Road.	"	" "	5	393	5	189½	7	694	6	523½
Dorion	"	" "	1	160	...	......	1	160	4	637½
Gillies	"	" "	....	....	1	79	....	....	2	239
Gorham.......	"	" "	1	164½	3	222½	3	462	4	543
Lybster	"	" "	1	80	...	......	....	....	1	80
Marks........	"	" "	....	....	1	1½	....	....	1	161½
McGregor	"	" "	5	801	...	......	2	305	2	201½
McIntyre	"	" "	....	....	...	......	....	....	....	....

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No. of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
O'Connor.....	Thunder Bay.	W. A. Burrows, Port	....	....	...	......	....	....	1	160
Oliver........	"	" Arthur	1	157	...	......	1	157	1	161
Paipoonge, N R	"	" "	....	....	...	......	....	....	....	......
" S R	"	" "	....	....	...	......	....	....	1	96
Pardee......	"	" "	....	....	...	......	2	280	1	160
Pearson......	"	" "	2	320½	...	......	1	160	....	......
Scoble........	"	" "	1	159½	...	......	3	470	2	318½
Stirling......	"	" "	11	1,291½	1	160	15	2,367	1	159½
Strange.....	"	" "	....	....	...	......	1	158	1	157
Ware	"	" "	5	560	3	107¾	2	254	10	966
Atwood	Rainy River..	William Cameron,	....	....	...	......	....	....	....	......
Blue	"	" Stratton	....	....	1	81	....	....	3	394
Curran........	"	" "	....	....	...	......	....	....	....	......
Dewart	"	" "	1	162	...	......	1	162	....	......
Dilke	"	" "	....	....	...	......	....	....	....	......
Morley.......	"	" "	1	164	...	......	1	164	....	......
Morson	"	" "	3	311¾	3	121	9	934¼	3	659
McCrosson ...	"	" "	2	321	...	......	2	321	....	......
Nelles........	"	" "	1	121½	...	......	....	....	2	242
Pattullo... ..	"	" "	5	594½	1	2	3	356½	2	243
Pratt	"	" "	....	....	...	......	....	....	1	156½
Rosebery	"	" "	....	....	...	......	....	....	....	......
Shenston.....	"	" "	....	....	...	......	....	....	1	81
Sifton	"	" "	3	480	2	97½	6	1,213	3	377½
Spohn	"	" "	3	501½	1	81	3	503½	1	157½
Sutherland ...	"	" "	2	319½	1	1	2	319½	1	1
Tait	"	" "	....	....	...	......	2	286	....	......
Tovell	"	" "	....	....	1	17½	....	....	2	320
Worthington..	"	" "	....	....	1	4	....	....	2	271
Aylsworth ...	Rainy River..	Alex. McFayden, Emo.	....	....	...	......	....	....	....	......
Barwick	"	" "	....	....	...	......	....	....	....	......
Burriss	"	" "	1	176½	...	......	1	176½	1	80
Carpenter	"	" "	....	....	2	20½	1	163	1	161½
Crozier.......	"	" "	1	164	2	200	1	164	2	322
Dance........	"	" "	2	319½	1	½	1	160	1	165½
Devlin	"	" "	....	....	1	6	....	....	3	368½
Dobie	"	" "	1	173	1	½	....	....	2	321
Fleming	"	" "	....	....	...	......	....	....	....	......
Kingsford	"	" "	2	318	...	......	2	198	1	159½
Lash..........	"	" "	....	....	2	42	....	....	3	210
Mather	"	" "	4	645½	2	80¾	6	956½	3	258½
Miscampbell .	"	" "	....	....	...	......	....	....	1	159
Potts	"	" "	....	....	3	323	1	159	3	483
Richardson...	"	" "	1	80	...	......	2	320½	2	317½
Roddick......	"	" "	....	....	...	......	....	....	....	......
Woodyatt	"	" "	....	....	...	......	....	....	....	......
Aubrey	Kenora	J. E. Gibson, Dryden..	2	239	...	......	2	193	1	151
Britton	"	" "	2	322	...	......	1	162	....	......
Eton.........	"	" "	2	320	...	......	2	320	....	......
Langton	"	" "	....	....	8	23	....	....	8	24
Melgund	"	" "	....	....	...	......	1	106	....	......
Mutrie......	"	" "	3	380	...	......	4	432	....	......
Redvers	"	" "	2	302	1	117	3	462½	....	......
Rowell	"	" "	....	....	...	......	1	103½	....	......
Rugby	"	" "	....	....	...	......	....	....	1	160
Sanford......	"	" "	1	80	1	80	1	80	1	159½
Southworth ..	"	" "	7	853½	...	......	4	534	1	161

Appendix No. 14.—Continued.

Township.	District or County.	Agent.	No. of persons located.	No of acres located.	No. of purchasers.	No. of acres sold.	No. of persons cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Temple	Kenora	J. E. Gibson, Dryden	1	160	...	......	2	320	....	....
Van Horne	"	" "	....	....	...	......	1	120	2	316
Wabigoon	"	" "	7	1,120½	1	76½	6	941½	3	523½
Wainwright	"	" "	4	665½	...	......	3	478½	1	160
Zealand	"	" "	3	506	2	245	5	724½	6	243
Melick	Kenora	W. L. Spry, Kenora	3	480	...	......	4	639½	2	239¾
Pellatt	"	" "	4	468	2	140½	4	514	2	246½
Balfour	Sudbury	J. K. MacLennan, Sudbury	1	160	...	......	1	160	....	....
Blezard	"	" "	....	....	...	......	....	....	3	122½
Broder	"	" "	1	202	2	109½	....	....	4	655½
Capreol	"	" "	....	....	1	200	1	146	1	40
Chapleau	"	" "	....	....	...	......	....	....	....	....
Dill	"	" "	....	....	...	......	....	....	....	....
Garson	"	" "	....	....	...	......	1	163	1	154½
Hanmer	"	" "	....	....	...	......	....	....	1	160½
Lumsden	"	" "	1	160	...	......	....	....	2	321½
Morgan	"	" "	....	....	...	......	....	....	....	....
Neelon	"	" "	2	317½	1	3½	9	1,231	2	316
Rayside	"	" "	....	....	...	......	....	....	1	101¾
Appelby	Sudbury	John Brown, Markstay	5	648½	1	1½	4	566	....	....
Casimir	"	" "	2	159½	...	......	....	....	1	141
Dunnet	"	" "	1	141	...	......	....	....	....	....
Hagar	"	" "	7	1,059½	...	......	3	480	1	100
Jennings	"	" "	....	....	1	80½	1	161	1	159
Kirkpatrick	Nipissing	" "	9	1,245½	2	29	....	....	6	970
Ratter	Sudbury	" "	4	585	...	......	1	160	2	314
Caldwell	Nipissing	J. A. Philion, Sturgeon Falls	3	320	...	......	....	....	9	1,131
Cosby	Sudbury	" "	2	321	...	......	....	....	1	160½
Grant	Nipissing	" "	1	147	...	......	1	147	1	159½
Macpherson	"	" "	8	863¼	3	3	....	....	8	1,184¼
Martland	Sudbury	" "	2	320½	...	......	1	160	1	160½
Springer	Nipissing	" "	4	355	...	......	....	....	5	412
Abinger	Lennox and Addington	Charles Both, Denbigh	....	....	...	......	....	....	....	....
Canonto, S.	Frontenac	" "	....	....	...	......	....	....	....	....
" N.	"	" "	....	....	...	......	....	....	....	....
Clarendon	"	" "	....	....	1	2	....	....	....	....
Denbigh	Lennox and Addington	" "	1	199	...	......	....	....	....	....
Miller (pt.)	Frontenac	" "	....	....	...	......	....	....	....	....
Palmerston	"	" "	....	....	...	......	....	....	....	....
McClintock	Haliburton	Unattached	....	....	...	......	....	....	....	....
Airy	Nipissing	"	2	263½	...	......	1	106	....	....
Finlayson	"	"	....	....	3	48¾	....	....	8	164
Murchison	"	"	....	....	...	......	....	....	....	....
Sabine	"	"	....	....	...	......	2	267	3	273½
*O'Brien	Temiskaming	"	49	....	...	......	....	....	....	5,018
*Owens	"	"	4	....	...	......	....	....	....	477
			425	54,182¾	110	4,570¼	360	47,715½	406	47,695

*Located under Returned Soldiers' and Sailors' Land Settlement Act, 1917

No. of lots assigned .... 166 No. of acres assigned 20,970

Appendix No. 14.—Concluded.

ISLANDS SOLD

Township	District or County	Agent	—
Islands in Lake of Bays, Franklin	Muskoka	J. B. Brown, Bracebridge	53/100
Island in Muskoka.............. Part of Craigenputtock, Muskoka	"	" "	5
Island D. B, Conger	Parry Sound........	Miss J. M. Campbell, Parry Sound	8
" Phœnix "	"	" "	4.50/100
" B 217 "	"	" "	7.80/100
" B 67 "	"	" "	1.30/100
" 372 A., Harrison	"	" "	37/100
(Pt.) H. B. 2 "	"	" "	6.60/100
Island A 660 "	"	" "	1.34/100
" A 661 "	"	" "	2.35/100
" A 499 "	"	" "	4.36/100
" B 502 Cowper	"	" "	4
" B 504 "	"	" "	5.50/100
" B 316 "	"	" "	40/100
" B 443 "	"	" "	90/100
Island in Wauquimakog Lake, Wilson	"	" "	14.75/100
Nivcent Island, Patterson........	"	W. H. Ellis, Powassan ..	2. 6/100
Island No. 2, Cavendish.........	Peterborough.......	A. N. Wilson, Kinmount.	8
			77¾

SELBY DRAPER, Free Grants Clerk.
W. C. CAIN, Chief Clerk.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 15.

Statement showing the number of purchasers and of acres sold; of lots resumed for non-performance of the settlement duties; and of patents issued in Townships other than Free Grant during the year ending 31st October, 1918.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Blount	Temiskaming.	S. J. Dempsay, Cochrane	370½	3	2	224	....	....
Brower	“	“ “	290½	2	3	454	....	....
Calder	“	“ “	726	5	3	452	....	....
Clute	“	“ “	2,248	15	16	2,472	5	784
Colquhoun	“	“ “	....	....	....	....	....	....
Fauquier	“	“ “	1,510	11	6	1,074	3	449
Fournier	“	“ “	619½	4	1	151	....	....
Fox	“	“ “	789	5	2	304	....	....
Glackmeyer	“	“ “	302	2	2	281	9	1,055
Kennedy	“	“ “	450	3	1	152	....	....
Lamarche	“	“ “	92	1	5	796	2	326
Leitch	“	“ “	....	....	1	80	....	....
Newmarket	“	“ “	1,260	8	5	804½	....	....
Pyne	“	“ “	989½	6	4	566½	....	....
Shackleton	“	“ “	1,512	10	9	1,168	....	....
Catharine	Temiskaming.	Jos. Woollings, Englehart	....	....	2	159½	1	152½
Chamberlain	“	“ “	158½	1	....	....	3	474½
Dack	“	“ “	....	....	....	....	1	160½
Eby	“	“ “	200	5	....	....	5	200
Evanturel	“	“ “	161	1	....	....	3	397
Gross	“	“ “	317	2	6	954	....	....
Ingram	“	“ “	156	1	1	157½	....	....
Marter	“	“ “	320½	2	4	639½	2	201
Marquis	“	“ “	320	2	2	320	1	158½
Otto	“	“ “	....	....	....	....	15	700
Pacaud	“	“ “	1,381	8	4	638½	1	40½
Pense	“	“ “	509½	4	....	....	....	....
Robillard	“	“ “	103	1	....	....	2	266
Savard	“	“ “	319	2	....	....	2	320
Sharpe	“	“ “	638½	4	1	159½	4	601
Truax	“	“ “	160	1	2	317	....	....
Armstrong	Temiskaming.	J. W. Bolger, New Liskeard	....	....	....	....	3	477½
Auld	“	“ “	....	....	2	215	....	....
Beauchamp	“	“ “	158½	1	2	269½	3	479
Brethour	“	“ “	320	2	....	....	6	958
Bryce	“	“ “	772	5	5	899	1	40
Bucke	“	“ “	402	3	....	....	4	587
Cane	“	“ “	402½	3	1	80	1	40
Casey	“	“ “	....	....	....	....	17	1,000
Dymond	“	“ “	159½	1	....	....	4	647
Firstbrook	“	“ “	365	3	2	325	1	40
Harley	“	“ “	....	....	....	....	2	320
Harris	“	“ “	80	1	....	....	1	158
Henwood	“	“ “	467½	3	....	....	5	654
Hilliard	“	“ “	324	2	1	159	2	310
Hudson	“	“ “	....	....	1	134	3	479
Kerns	“	“ “	160	1	....	....	4	396
Lundy	“	“ “	165½	1	1	160½	1	159
Tudhope	“	“ “	603½	4	5	908	5	200½
Smyth	Temiskaming.	H. E. Sheppard, Elk Lake	319½	2	1	158½	3	120
Lorrain	Temiskaming.	Neil J. McAulay, Haileybury	583½	....	1	160	2	93½

Appendix No. 15.—Continued.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Beatty	Temiskaming.	F. E. Ginn, Matheson	545	4	1	319½	10	664
Benoit	"	" "	93½	7				
Bond	"	" "	1,769	11	3	397½		
Bowman	"	" "	156	1	5	801	5	768
Calvert	"	" "	635½	4	1	320½	1	160
Carr	"	" "	626	4	2	317	7	1,078
Clergue	"	" "	639½	4	4	797	6	522
Currie	"	" "	464½	3	4	592	1	160½
Dundonald	"	" "	694	5	2	835½		
Evelyn	"	" "	325½	3	2	325½		
German	"	" "	438½	3	9	1,468	1	2
Hislop	"	" "	1,743	11	6	1,020	1	½
Matheson	"	" "	471½	3	2	213½	1	160
Mountjoy	"	" "	1,811	12	4	787	1	148½
McCart	"	" "	748	5	1	323½		
Playfair	"	" "	921	6	1	313½	1	161
Stock	"	" "	474	3	8	491	1	144
Taylor	"	" "	456½	4	4	749½	2	1½
Walker	"	" "	717	5	3		2	319½
Casgrain	Algoma	T. V. Anderson, Hearst.	548	4	1	252	1	148
Eilber	"	" "	160	1	5	731		
Hanlan	"	" "	1,307	9	5	765	1	196
Kendall	"	" "	599	4	82	12,819	4	537
Lowther	"	" "	875	6				
Forbes	Thunder Bay.	W. A. Burrows, Port	654½	5	2	322		
Lyon	"	" Arthur	1,046½	6	9	1,784½	6	867
Nepigon	"	" "	401	3	1	317½	4	615
Aweres	Algoma	E. Noble, Sault Ste. Marie					1	116
Tarentorus	"	" "			1	160		
Vankoughnet	"	" "			3	615		
Watten	Rainy River	C. J. Hollands, Fort Frances						
Bright	Algoma	Thos. Dodds, Thessalon.					1	154
Day	"	" "	431		1	309	1	110
Gladstone	"	" "						
Haughton	"	" "	144	1				
Johnson	"	" "						
Kirkwood	"	" "	147	1				
Parkinson	"	" "	480½	3				
Patton	"	" "	160	1	2	238½	1	160
Rose	"	" "			1	157	2	312
Striker	"	" "			1	62		
Wells	"	" "	2	1				
Hallam	Sudbury	R. W. Teasdale, Massey	161	1			1	80
Harrow	"	" "	612	5			3	308
May	"	" "	587	6			3	483½
Salter	"	" "	357	4			3	411
Shedden	Algoma	" "	160	1				
Victoria	"	" "					1	80
Dowling	Sudbury	J. K. MacLennan, Sudbury	79	1			7	324
Scollard	Nipissing	J. A. Philion, Sturgeon	160	1			1	161
Mason	"	" " Falls						

Appendix No. 15.—Continued.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Hugel	Nipissing	John Brown, Markstay.	160	1				
Widdifield	Nipissing	W. J. Parsons, North Bay	1,755	11	4	640	6	940
Nairn	Sudbury	Edward Arthurs, Espanola	391½	3			1	167
Admaston	Renfrew	Unattached	90	1			3	240
Bagot	"	"	300	3			1	100
Blithfield	"	"					1	190
Bromley	"	"					2	480
McNabb	"	"	50	1				
Stafford	"	"					1	100
Westmeath	"	"	100	1			1	100
Alfred	Prescott	Unattached						
Adolphustown	Lennox	Unattached						
Anglesea	"	"	200	2			1	225
Effingham	"	"	102	2			3	117
Kaladar	"	"					2	425
Sheffield	"	"					1	200
Artemesia	Grey	Unattached					1	16¾
Bentinck	"	"					5	439¼
Egremont	"	"					4	355
Glenelg	"	"					3	395
Holland	"	"					3	257
Normanby	"	"					2	183
Osprey	"	"					2	209
Proton	"	"	47	1			1	99
Sullivan	"	"					4	450
Sydenham	"	"					1	100
Arran	Bruce	Unattached						
Brant	"	"					2	152
Bruce	"	"					3	250
Culross	"	"					1	125
Elderslie	"	"					8	634
Greenock	"	"						
Huron	"	"						
Kincardine	"	"						
Saugeen	"	"					1	25
Barrie	Frontenac	Unattached	100	1			1	100
Bedford	"	"					1	1
Kennebec	"	"						
Olden	"	"	115½	1			1	115½
Bathurst	Lanark	Unattached						
Beckwith	"	"					2	200
Elmsley	"	"						
Lanark	"	"						
Plantagenet	"	"						
S. Sherbrooke	"	"					1	400
N. Sherbrooke	"	"						
Sandwich, E.	Essex	Unattached					1	$\frac{87}{100}$
Sandwich, W.	"	"					1	$\frac{80}{100}$
Seymour	N'thumberl'd.	Unattached						

Appendix No. 15.—Continued.

Township.	District or County.	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. of patents issued.	No. of acres patented.
Carden	Victoria	Unattached					1	106½
Dalton	"	"					1	104
Digby	"	"					2	487
Laxton	"	"					1	102
Somerville	"	"					1	201
Edwardsburgh	Grenville	Unattached						
Dummer	Peterborough	"					1	50
Harvey	Peterborough.	Unattached	97½	1			2	194½
Haughton	Norfolk	Unattached						
Hungerford	Hastings	Unattached	100	1			2	200
Tudor	"	"	166½	2			5	301
Trafalgar	Halton	"					3	8
Rama	Ontario	Unattached					1	341
Cornwall	Stormont	Unattached					2	196
Roxborough	"	"					1	152
Matchedash	Simcoe	Unattached	100	1			1	80
W.Gwillimbury	"	"					1	60½
Arthur	Wellington	Unattached					1	100
Peel	"	"						
Humberstone	Welland	Unattached					4	263
Wainfleet	"	"	31	1			1	31
Maisonville	Temiskaming.	Unattached					20	638
Allen	Sudbury	Unattached	12	1			1	12
Bigwood	"	"						
Burwash	"	"					1	176½
Dennison	"	"						
Drury	"	"						
Dryden	"	"					2	160
Falconbridge	"	"						
Gough	"	"	328	2				
Graham	"	"						
Levack	"	"					5	196
Lorne	"	"	600	4			4	600
Louise	"	"	298½	2			2	298½
MacLennan	"	"	231	2				
Snider	"	"					2	95
Waters	"	"						
Badgerow	Nipissing	Unattached					4	531
Bastedo	"	"						
Crerar	"	"					2	219
Field	"	"					2	2
Gibbons	"	"	160	1			1	160
Drayton	Kenora	Unattached	67½	2			2	67½
Malachi	"	"	5	1			1	5
Redditt	"	"					1	17¾
Chesley	Algoma	Unattached					2	80½
Cobden	"	"	164½	1			1	164½
Gould	"	"						
Pic	Thunder Bay	Unattached					2	70

Appendix No. 15.—Concluded.

Township.	District or County	Agent.	No. of acres sold.	No. of purchasers.	No. of sales cancelled.	No. of acres resumed.	No. patents issued.	No. of acres patented
Townsite— Armstrong..	Temiskaming.	Unattached	....	....	....	....	1	1/5
Grant	"	"	5	5	....	....	2	2½
MacFarlane.	Kenora	"	.23	1	....	....	3	
Sioux Lookout.......	"	"	....	....	....	....	4	1½ 4
Dryden	"	"	....	....	....	....	....	1½
Winnipeg River Crossing.	"	"	.25	1	....	....	3	1½
Hearst	Algoma......	T. V. Anderson	....	....	....	....	8	2¼
Hilton	"	W. E. Whybourne, Marksville	16	1	....	....	1	33
Capreol	Sudbury	.Unattached	....	....	....	....	1	91/100
Gowganda....	Temiskaming.	"	....	....	11	½	....	....
Iroquois Falls	"	F. E. Ginn, Matheson..	....	....	....	....	2	61/100
Kirkland Lake	"	Unattached...........	1	1	....	....	....	....
Muskokaville .	Muskoka.....	J.B. Brown, Bracebri'ge	2	1	....	....	....	....
Inverhuron ..	Bruce........	Unattached...........	....	....	....	....	1	52½
Amherstburg..	Essex........	"	....	....	....	....	2	¾
Eugenia	Grey	"	1½	1	....	....	1	1½
Petewawa....	Renfrew.....	Finlay Watt, Renfrew.	3/5	2	....	....	....	....
Barrie........	Simcoe......	Unattached	....	....	....	....	1	3
Holland Landing	York........	"	....	....	....	....	1	4
		WATER LOTS.						
City— Brockville ..	Leeds	Unattached...........	7/10	1	....	....	1	7/10
Kingston ...	Frontenac ...	"	¼	1	....	....	1	¼
Saltfleet......	Wentworth ..	"	3¼	9	....	....	9	3¼
Ft. William.	Thunder Bay.	W. A. Burrows, Port Arthur	21¾	2	....	....	2	21¾
		ISLANDS.						
Mason— Part Island C	Nipissing	J. A. Philion Stayner Falls	9½	2	....	....	2	9½
Rama— Rama Island	Ontario	Unattached...........	4	1	....	....	1	4
Bedford in— Wolf Lake..	Frontenac ...	"	1	1	....	....	1	1
Effingham— Island A ...	Lennox and Addington.	"	15	1	....	....	1	15
Crosby— Island G ...	Leeds	"	½	1	....	....	1	½
Lansdowne— Dominion Island........	"	"	2⅘	1	....	....	1	2⅘
Total		....	50,733	386	295	45,027½	422	36,900

Number of lots assigned........22 Number of acres assigned........2820
Number of sales restored.......19 Number of acres restored.........3107

W. R. LEDGER, Sales Clerk.
W. C. CAIN, Chief Clerk in Charge.

ALBERT GRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 16.

Statement of Crown Surveys completed and closed during the twelve months ending October 31st, 1918.

No	Date of Instructions.	Name of Surveyor.	Description of Survey.	Amount Paid.	No in Acres.
				$ c.	
1	April 20, 1915	Lang & Ross ...	Survey of Islands on the north shore of Lake Huron and Georgian Bay, Districts of Manitoulin and Parry Sound	3,690 10	
2	July 13, 1917	D. J. Gillon	Survey of Namakan River, District of Rainy River	569 47	
3	July 24, 1917	J. L. Morris	Survey of the Township of Kapuskasing, District of Algoma	2,094 47	51,444
4	Oct. 30, 1917	David Beatty ...	Re-survey of the Township of O'Brien, District of Algoma	1,335 35	52,062
5	Oct. 19, 1917	H. M. Anderson.	Re-survey of the Township of Owens, District of Timiskaming.	3,988 20	51,920
6	Oct. 24, 1917	J. S. Dobie	Survey of the Township of Idington, District of Algoma	7,255 13	51,959
7	May 12, 1918	Jas. Hutcheon ..	Examination of Cadwell Water Lot on Lake Erie	62 47	
8	Jan. 26, 1918	S. B. Code	Survey of Islands in Rideau Lake within the limits of Lot 14, Concession I, Township of Burgess..	138 00	
9	Jan. 26, 1916	McAuslan & Anderson	Survey of Peter Long Lake, in the Districts of Timiskaming and Sudbury	318 18	
10	May 12, 1918	Jas. Hutcheon ..	Examination of Cadwell Water Lot on Lake Erie. Expenses of J. J. Newman	47 15	
			Aikenhead Hardware Co., boom chains and wire	7 15	
				19,505 67	207,385

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister Lands and Forests.

Appendix No. 17.

Statement of surveys in progress during the twelve months ending October 31st, 1918.

No.	Date of Instructions.	Name of Surveyor.	Description of Surveys.	Amount Paid.
				$ c.
1	Sept. 7, 1917	A. L. Russell ...	Survey of the shores of low Shebandowan Lake, District of Thunder Bay	392 50
2	June 17, 1918	Phillips & Benner	Survey certain boundaries of the Black Sturgeon River Pulp and Timber Limit, District of Thunder Bay	4,305 00
3	April 20, 1918	H. J. Beatty	Survey of certain outlines of townships, District of Timiskaming	2,598 75
4	May 20, 1918	David Beatty ...	Survey of the Township of Williamson, District of Timiskaming	5,334 00
5	June 14, 1918	E. R. Bingham..	Survey certain base and meridian lines, District of Thunder Bay	3,441 37
6	June 26, 1918	Lang & Ross	Survey of the Township of Cumming, District of Algoma	5,250 00
				21,321 62

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister Lands and Forests.

Appendix No. 18.

Statement of Municipal Surveys for which instructions issued during the twelve months ending October 31st, 1918.

No.	Name of Surveyor.	No.	Date of Instructions.	Description of Survey.
1	W. A. & W. H. Brown	716	Feb. 14, 1918	To survey the road allowance between lots Nos. 10 and 11, in the third concession, Township of East Gwillimbury, County of York, and to mark the limits of said road allowance by durable monuments on the ground.
2	S. B. Code ...	717	June 4, 1918	To survey the road allowance between concessions 5 and 6, in the Township of Goulburn, across lots 16, 17 and 18, and that stone or other durable monuments be placed to mark the limits of the said road allowance.
3	George Ross ..	718	July 8, 1918	To survey the sideline road allowance between lots 8 and 9 through the whole breadth of the Township of Crowland, in the County of Welland, and also the side road allowance between lots 16 and 17 across the 6th concession of said township, and that stone or other durable monuments be placed to mark the said road allowance ....
4	Roger M. Lee..	719	Oct. 22, 1918	To survey the original road allowance between lots 13 and 14, in the 1st concession of the said Township of Wainfleet, in the County of Welland, and that stone or other monuments be planted to mark the position of said road allowance at the intersection with the road allowance between the 1st and 2nd concessions, and at different points to the lake shore ....

L. V. RORKE,
Director of Surveys.

ALBERT BRIGG,
Deputy Minister of Lands and Forests.

Appendix No. 19.

Statement of Municipal Surveys confirmed during the twelve months ending October 31st, 1918.

No.	Name of Surveyor.	No.	Date of Instructions.	Description of Surveys.	Date when confirmed under R.S.O. 1914, Chap. 166, Secs. 10-15 inclusive.
1	MacKay, MacKay & Webster	7477	April 21, 1915	To survey the westerly part of the Toronto and Hamilton Highway	Jan. 22nd, 1918
2	Oliver Smith ...	711	May 30, 1917	To survey the concession road allowance between concessions 4 and 5 in the Township of Verulam across lot No. 5 and that stone or other durable monuments be placed at the front angles of lot No. 5 in the 5th concession	July 10th, 1918
3	E. D. Bolton ...	715	Sept. 21, 1917	To survey the road allowance between lots 10 and 11, across concessions 9 and 10, in the Township of Egremont, in the County of Grey, and to plant stone or other durable monuments to mark the boundaries of said road allowance	July 22nd, 1918

L. V. RORKE,
Director of Surveys.

ALBERT GRIGG,
Deputy Minister Lands and Forests.

Appendix No. 20.

SURVEY OF THE TOWNSHIP OF KAPUSKASING, DISTRICT OF ALGOMA.

PEMBROKE, March 20th, 1918.

SIR,—I have the honor to submit the following report on the survey of the Township of Kapuskasing, in the District of Algoma, in accordance with instructions dated July 24th, 1917.

The Canadian Northern passes through this township, crossing the eastern boundary in concession four it runs in a north-westerly direction, crossing the Nemegosenda and Kapuskasing Rivers, and skirting the north end of Kapuskasing Lake it crosses the west boundary in concession ten, there being one station in the township named Agate, about thirty chains from north-west corner of the lake, but no accommodation exists at present for freight or passengers.

I commenced my survey in the latter part of August, 1917, by retracing the south boundary from south-east corner westerly, this was run by O.L.S. Niven in 1899, but owing to a bush fire having run through that section in the fall of that year, it was impossible to follow same in places and I had to cut out a new line for the first five miles. On the remainder of this boundary, excepting in swamps, the second growth was so thick that a line had to be re-cut before it could be chained and posted. The north boundary was run by O.L.S. Beatty, in 1912, and nearly all of this had also to be re-cut before we could post it. Chaining westerly along the south boundary I made each lot twenty-five chains and twenty-five links in width, and after making the proper allowance for roads, the meridians were run north astronomically, from this boundary, in the centre line of road allowance between lots six and seven; between twelve and thirteen; between eighteen and nineteen and between twenty-four and twenty-five; the concession lines were run west astronomically as chords of latitude, from the points determined upon on the east boundary between concessions two and three; between four and five and between six and seven; the other two concession lines were run east and west from points established on side line between lots six and seven. The survey was carried out in accordance with instructions; substantial wooden posts being planted at all lot corners and at all intersections of surveyed lines with road allowance along the rivers, lakes and right-of-way of the railroad; wooden guide posts being planted in centre line of road allowance, iron posts being planted where instructed. The field notes show result of survey in detail. The intersections of all surveyed lines with centre line of railway were carefully noted and sufficient measurements taken to accurately locate the centre line of railway right-of-way.

A careful traverse was made of Nemegosenra River and of Kapuskasing Lake and River, and ties made to the islands in the lakes and posts marked thereon. An allowance for road one chain in perpendicular width was laid out on both sides of above mentioned rivers and around the lake, also around the north side of small lakes on the south boundary on lots fourteen and fifteen. All lines were well cut and blazed, bearing trees being taken for all posts at lot corners. Frequent observations for azimuth were taken.

Generally speaking this township is covered with a thick growth of timber, principally spruce from four to nine inches in diameter, with scattered areas of poplar, balsam, white birch, and cedar varying in size from five to fifteen inches in diameter, there being a thick growth of underbrush throughout the township, making the cutting of lines very heavy. Prior to the construction of the railway

there were scattered areas with spruce from fifteen to twenty-four inches in diameter, but this was practically all removed for railroad construction purposes.

Along the Nemegosenda River the banks are low with marshes extending from five to twenty chains back, the subsoil being clay, along the Kapuskasing the banks are a little higher, but both streams overflow their banks for considerable areas during the spring freshet. Kapuskasing Lake is very shallow with a hard clay bottom, the banks being mostly low; and are flooded in a great many cases during high water. The railway crosses a small bay in northwest corner of the lake on a trestle about fifty chains long, and nearly all the piles for a trestle were driven across the bay in the north-east corner of the lake, but for some reason this was abandoned and the railway diverted to the north. Owing to the lake being so shallow, it is very rough during wind storms, which are of frequent occurrence and detract from the value of this lake as a summer resort. The water in the lake is usually of a muddy color, and fish can only be taken by nets; there being a plentiful supply of white fish, pike and pickerel.

A small Indian village, with shacks, occupied by six or seven families, is situated on lot eleven, concession seven, south of the railway, and I understand Indians have been living on this point for about eighty years. They of course trap and hunt in the winter and obtain a bountiful supply of moose meat along the rivers in the summer.

The surface is mostly level and swampy with occasional ridges which seldom rise to a height of more than fifty feet above the lake level, the north-west corner being somewhat broken, with Mount Horden situated on lots twenty-five and twenty-six, concession eleven, on which fire rangers have built one of their look-out stations, from which I understand a very extensive view is obtained, this being one of the land marks of this section.

Owing to the greater portion of the township being swampy with deep moss, and the ridges being mostly sandy loam, I do not consider it is suitable for agricultural development, its chief asset being timber suitable for pulpwood; the best land noticed was on line between concessions eight and nine, lots one to six inclusive, and on line between concessions two and three, lot nineteen to twenty-eight. Between Nemegosenda River and Kapuskasing Lake the land is mostly wet and swampy, the same may be said of that portion north of the railway and west of Kapuskasing River, while that portion south of the railway and west of the lake is about half swamp and half rolling; with drainage it might turn out good agricultural land, but I do not consider that more than thirty per cent. of the township is suitable for agricultural purposes.

No economic minerals are noted and there are no sites for water powers.

Accompanying this report are a general plan, timber plan, field notes including traverse sheets, the customary affidavits and account in triplicate.

I have the honour to be, Sir,

Your obedient servant,

(Signed) J. L. Morris,

Ontario Land Surveyor.

The Honourable the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 21.

Re-Survey of the Township of O'Brien, District of Algoma.

PARRY SOUND, February 21st, 1918.

SIR,—I have the honour to submit the following report on the re-survey of the Township of O'Brien, in accordance with your instructions, dated August 30th, 1917.

This township was surveyed under the nine-mile system, by O.L.S. Fullerton, 1913, and his report, dated April 11th, 1914, which is now on file in your Department, so fully describes the township that it is not necessary for me to go into it in detail, he having run all the side lines and concession lines would have a better opportunity of reporting on the natural resources of this township than I have, seeing that I only ran certain concession lines. Suffice it to say that I consider this township the best I have yet seen in Northern Ontario.

The experimental farm on the west side of the Kapuskasing River, adjoining the Transcontinental Railway, fully demonstrates the splendid quality of the soil for agricultural purposes. A fair sized town is in the making on the east side of the Kapuskasing River, adjacent to the railway, for the housing of returned soldiers, who were busily engaged in preparing land for settlement.

Practically all of the larger timber has been removed for railway and construction purposes, the Kapuskasing and Woman Rivers affording convenient means of getting this timber to the railroad. What is now standing is suitable for pulpwood and fuel only. That suitable for pulpwood I found mainly in the north and south portions of the township, that in the centre of the town being mainly smaller timber from three to six inches in diameter.

My field notes are prepared from survey made by me of the lines between Concessions 2 and 3, 4 and 5, 8 and 9, 10 and 11, 14 and 15, 16 and 17, and the field notes of Concession 6 and 7, 12 and 13, are copied from those of Mr. Fullerton's, the only alterations I had to make being the changing of the markings of the posts due to the new numbers of the concession lines. The field notes I am returning of the side lines have been compiled from Mr. Fullerton's field notes, the depths of the concessions being obtained by chaining, from the intersection of the concession lines run by me with the side lines run by Mr. Fullerton, to the nearest post planted by him. The blank lines between Concessions 3 and 4, Concessions 9 and 10, and Concessions 15 and 16, were run in the original survey by Mr. Fullerton as concession lines between Concessions 2 and 3, 6 and 7, 10 and 11 respectively, and on these lines I destroyed his posts, but they now mark the blank lines between the concessions above enumerated, posts being planted by me at their intersection with the side lines. Posts along the Transcontinental Railway planted by Mr. Fullerton from Lots 1 to 12 inclusive were destroyed by me, as this part of the railway is not now the front of a concession.

A sufficient number of observations were taken to check the bearings of the lines, and the field notes of the lines run by me show the results of the survey in detail. The plan accompanying this report has been compiled from my survey notes and from Mr. Fullerton's plan and field notes.

Game does not appear to be very plentiful. Moose trails were noticed in the north-east corner of the township around Lily Lake. The only evidence of fur-

bearing animals was a couple of beaver dams. Owing to this survey having been performed in the late fall, I am not able to state anything about fishing.

Accompanying this report are a general plan, field notes, the usual affidavits and account in triplicate.

All of which is respectfully submitted.

I have the honour to be, Sir,

Your obedient servant,

(Signed) David Beatty,

Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ontario.

Appendix No. 22.

Survey of the Township of Owens, in the District of Timiskaming.

North Bay, February 9th, 1918.

Sir,—In accordance with instructions from your Department, bearing date of October 19th, 1917, I have made a re-survey of the Township of Owens, in the district of Timiskaming, the field work being completed on the 28th day of November following the date of instructions.

The township of Owens was originally subdivided by O.L.S. Bingham in 1915, and under these instructions the township was to be resubdivided into lots of about 99.8 acres each, as against the former subdivision of 150 acres per lot. To do this, the former lines were to be adhered to, while what was formerly two concessions was to be subdivided into three concessions, thus involving the adhering to certain of the former concession lines, obliterating others, and opening certain new ones. The following report is submitted as to the work done.

The lines between Concessions 3 and 4, 9 and 10 and 15 and 16 were run and posted in the original survey and, as these are now blind lines in the new survey, all the posts on these lines were removed and destroyed, and their accompanying B.T.'s destroyed. New posts were planted on these lines at the east and west sides of the side road allowance.

The lines between Concessions 6 and 7 and 12 and 13 were also run and posted in the former survey, and, as these lines are being adhered to, the original posts thereon were recarved to show the new concession numbers. Similar treatment was given to the original posts on the south and north boundaries of the township, and on these lines common to both surveys the fronts of Lots 28 were chained, and posted midway to divide Lot 28 into Lots 28 and 29.

The new concession lines cut were those between Concessions 2 and 3, 4 and 5, 8 and 9, 10 and 11, 14 and 15, and 16 and 17. These were run in pairs as follows:—

The first mentioned two were run westward through the township from the east boundary, the second two were run west and east from the 25th side line, while the third pair were run west from the east boundary. The side lines were not re-chained throughout their length, the block depths as per the former survey being assumed correct. A chainage was, however, made at each side line to ascertain the depth between the new concession lines, and those of the former survey being abandoned. The survey was thus fairly well under control, though, as stated, no re-chainage was made to prove the correct residuary depths along the side lines.

On the north boundary of the township it was found that there had been no post planted, at nor-west of the 18th side line, by the surveyor in his original subdivision, and so this portion of the boundary was opened out and posted. It was also found that, on the north boundary, the original stakes marking the north-east angles of Lots 16, 17, 18 were, in each case, 10 chains too far east, and these errors were corrected.

Iron posts were planted, at certain specified positions throughout the township, and these positions are indicated both on the plan and in the field notes.

In the field notes returned you will observe that for all the lines save those newly cut, the notes of O.L.S. Bingham have been copied for topography as well as chainage and bearings; while full original notes are included for the new work performed by my party.

The lines were well cut out and thoroughly blazed, bearing trees clearly scribed, and full-sized posts firmly seated.

General Features.

The township of Owens will be found to lend itself very naturally to farming, there being fully 90 per cent. of the land well drained and tillable, and the soil of a loose texture clay loam. There are no rough nor rocky areas, the other 10 per cent. of the area being, for the present, rather wet. There are numerous small streams cutting through the township, and two branches of the Lost River in the north-west quarter of the township are quite fair sized rivers. The Kapuskasing River flows northerly through the south-east corner of the township, and these streams will render much aid to the transporting of pulp wood to the track of the National Transcontinental Railway, which traverses the north-east corner of Owens.

Timber.

The timber burden is almost entirely spruce, some few large whitewood occuring on certain of the uplands. Along the streams the white spruce attain at times to a butt measurement of 20 inches, while inland the timber is of good commercial size for pulp wood.

Minerals.

No exposed rock was encountered during the progress of the survey, and no economic minerals are known to exist within the limits of the township.

Accompanying this report are the usual returns, consisting of plan and tracing, field notes, etc., etc., all of which is respectfully submitted,

I have the honour to be, Sir,

Your obedient servant,

(Signed) H. M. ANDERSON,

Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ont.

Appendix No. 23.

SURVEY OF THE TOWNSHIP OUTLINES ON THE SOUTH SIDE OF UPPER ABITIBI LAKE, IN THE DISTRICT OF TIMISKAMING.

PEMBROKE, September 28th, 1918.

SIR,—I beg to report that I have completed survey of township outlines on the south side of Upper Abitibi Lake, in the District of Temiskaming, under instructions from your Department, dated April 20th, 1918, and beg to submit the following report.

I left the Transcontinental Railway at Low Bush and proceeded by boat to the mouth of the Ghost River, and proceeded up that river by canoes to trail from McCool Creek to the east boundary of Indian Reserve, which I followed to posts at the south-east corner of Reserve planted by J. H. Shaw, O.L.S., from this point I ran south, a distance of thirteen chains and sixty-eight links, and then ran my base line east a disance of two miles, seventy-nine chains and twelve links, where I planted 1¾-inch iron bar and spruce post establishing corner of Rand, Garrison, Harker and Lamplugh townships, from this my first meridian was run south to Newman's base line and north to the Abitibi Lake. I then continued my base line east to intersection of production of line between Harker and Holloway townships, moving Newman's iron post north a distance of thirteen chains and sixty-three links and planting it along side spruce post in cairn of stones marking the corner of Lamplugh, Harker, Holloway and Frecheville townships, from this post by second meridian was run north astronomically to Abitibi Lake. I then continue by base line east to the boundary line between Ontario and Quebec, intersecting same at a distance of thirty-two chains and eighty-five links north of the sixty-seventh mile post, where I planted 1¾-inch iron bar alongside spruce post in pile of stones. I then proceeded to the corner of Tannshill and Dokis townships, on Newman's base line, and ran my third meridian north to intersection with my base line, where I planted 1¾-inch iron bar alongside spruce post marking corner of Frecheville, Holloway, Marriott and Stoughton townships, and

continued this meridian north to the south side of Abitibi Lake, where I planted 1¾-inch iron bar along side spruce post, at a distance of thirty links from high water mark.

Along the base line forming boundary of Rand and Garrison townships the soil is of good clay, fairly level, suitable for agricultural purposes, timbered with spruce and balsam from 4 to 12 inches in diameter with some white birch and poplar in places, and similar conditions prevail along base line between Lamplugh and Harker townships as far as Ghost River, after crossing which the ground is rolling and rising to the foot of Ghost Mountain, the latter being crossed just south of its summit at an elevation of about six hundred feet above lake level. The base line continues through a broken, hilly country, with frequent rocky knolls unsuitable for agricultural purposes, the timber being principally white birch, spruce and balsam, with thick alder underbrush, till we reach the corner of Lamplugh, Harker, Holloway, and Frecheville townships, which is situated about the south-west corner of Lightning Mountain, continuing along the base line forming boundary between Frecheville and Holloway townships, the country is rolling and broken with frequent outcrops of rocky knolls from thirty to one hundred feet high, timber being principally white birch up to fifteen inches in diameter, with spruce, balsam and poplar prevailing in the level areas between ridges where soil is mostly clay; continuing along the boundary between Stoughton and Marriott townships the land gradually improves for the first mile and a half until we enter a fairly level section of good clay soil extending to the interprovincial boundary, timbered with balm of gilead, poplar, spruce and balsam, with very thick underbrush.

Along the first meridian forming boundary between Garrison and Harker townships from Newman's base line north for the first two miles the land is fairly level but sandy and stony in places, with low ridges from twenty to thirty feet high, higher ground being reached on the third and fourth miles, but falling again to where we cross what I think is main branch of Ghost River, the timber being principally spruce on lower levels with white birch and balsam predominating on higher land, and is not suitable for agricultural purposes. From branch of Ghost River north to my base line the soil is of good clay, suitable for agricultural purposes.

Along line between Rand and Lamplugh townships, after leaving base line, the land is rolling and sandy for a mile and a half till we approach Ghost River, along which the land is low and marshy in places to where meridian crosses river on the fifth mile, higher ground being met from there onward to Lake Abitibi.

Going north on second meridian between Lamplugh and Frecheville townships there is a sharp rise over the westerly end of Lightning Mountain and dropping at once over rough, rocky land to base of mountain about ten chains south of first mile post, the remainder of this meridian runs through fairly level land, marshy in places, adjoining Lightning River, which is crossed on the fifth mile, timber being principally spruce, with white birch and balsam on the higher ground.

Going north on the third meridian between Holloway and Marriott townships from Newman's base, the first mile is through level clay land with heavy growth of spruce and balsam, then we passed through rolling land with sandy ridges till we reached the base line, and continuing north along line between Frecheville and Stoughton we met with fairly good agricultural land, timber being chiefly spruce and balsam with scattered poplar, and crossed an old brulé on the fifth mile.

From what I could see off the base line, the townships to the south appear to be broken and hilly with considerable areas of spruce swamp, and that to the north is not so broken. There appears to be some good land along Ghost River in Rand and Lamplugh Townships, and along the Matawasagi River in Stoughton. Taken as a whole the area covered by this survey is chiefly valuable for its spruce timber and has not sufficient good land to warrant development along agricultural lines.

No indications of economic minerals were found, but the rock formation and mineral resources were fully investigated this summer by the Department of Mines.

Ghost, Lightning and Matawasagi Rivers are all sluggish streams, the last mentioned being the largest and is navigable by boat of light draught for about four miles from Lake Abitibi. Ghost River is next in importance and is navigable by canoes for about a mile south of base line, it flows through a march, about three miles long and from twenty chains to one-half mile in width, in the south-westerly portion of Lamplugh Township.

Frequent observations for azimuth were taken and substantial wooden pile post planted, with 1¾-inch iron bars properly marked alongside wooden posts at township corners and ¼-inch bars at the three mile posts, the lines being well cut out and trees blazed.

Moose are very plentiful, but the fishing in rivers is not good as far as our experience went.

Accompanying this report are field notes, a general plan, and account in triplicate.

I have the honour to be, Sir,

Your obedient servant,

(Signed) Herbert J. Beatty,

Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ont.

Appendix No. 24.

Survey of the Township of Idington, in the District of Algoma.

Thessalon, June 1st, 1918.

Sir,—In accordance with your instructions, dated October 24th, 1917, I have made a survey of the Township of Idington, in the District of Algoma, and beg to submit the following report.

This township is bounded on the east by the Township of Williamson, at present unsurveyed, on the west by the Township of McCrea, which was sub-

divided some years ago, on the north by the unsurveyed Township of Neely, and on the south by the unsurveyed lands of the Crown. The north boundary of this township was run in 1900, being part of the base line run by O.L.S. Niven in that year. The east, west and south boundaries were run in 1906 by O.L.S. Niven.

The Township of Idington was surveyed into lots of 100 acres or thereabouts, the dimensions of the regular lots being 25.25 chains frontage by 39.60 chains in depth. There are 18 concessions, and 28 lots in each concession, lot 28 being wider than the other lots. A road allowance one chain in width was surveyed between every second concession, that is between concessions 2 and 3, 4 and 5, 6 and 7, etc., the line being run in the centre of the road allowance. Similar road allowances were also surveyed between Lots 6 and 7, 12 and 13, 18 and 19, 24 and 25, the side lines being run in the centre of the road allowances.

The survey was started on November 4th, the party having arrived at Harty station, on the National Transcontinental Railway, the night previous. The south-east corner was located, this point being marked by an iron post planted by O.L.S. Niven, and a distance of 80.20 chains was measured northerly along the east boundary, from this iron post, to the centre of the road allowance between Concessions II and III. This gave to each concession a depth of 39.60 chains and allowed for half the width of the road allowance on the south boundary, and on the front of Con. II. At this point an observation was obtained on Polaris, which showed O.L.S. Niven's meridian to be correct. From this point a line was run westerly on a nine-mile cord, down the centre of the road allowance between Concessions II and III, to the centre of the road allowance between Lots 6 and 7, giving each lot a frontage of 25.25 chains, and leaving half the width of the road allowance along the east boundary. The side line between Lots 6 and 7 was run south to the south boundary and then north across the township to the north boundary of the township. This line was used as the base for the survey, all concession lines being started from it and run east to the east boundary, and west to the west boundary.

Each concession line was run as a nine-mile chord, and the side lines were run as true meridians. All the lines were run with a transit, and observations were taken on Polaris every clear afternoon. For this purpose a sidereal watch was carried, and the astronomical tables supplied by the Department of the Interior were used and found to be of great assistance.

Excepting for the fact that the regular concessions are of a depth of 39.60 chains instead of 59.50 chains the township was surveyed in a manner similar to the other nine-mile townships in the Clay Belt. The posts marking the corners of the lots are planted 50 links from the line run down the centre of the road allowance, and a guide post was left on the line opposite the corner at the front of each lot, and at the point where the side and concession lines intersected. These posts were all of the most durable wood obtainable, and were carefully marked with a scribing iron. Bearing trees were marked and noted in the field notes wherever possible.

A road allowance one chain in width was laid off along the shore of every lake encountered during the survey and also along each bank of the Opazatika River. A similar road allowance was laid off on each side of the National Transcontinental Railway.

The Opazatika River, and the above mentioned lakes were all traversed on the ice, by transit and chain, and the details of the traverses are shown in the field notes.

In order to make the survey more permanent, 25 iron posts were planted, in addition to iron posts planted on previous surveys. The iron posts are each $1\frac{1}{4}$ inches in diameter, and were planted at the following points:—

S.W.	corner	Lot 12,	Concession	I	S.W.	corner	Lot 18,	Concession	XI
S.W.	"	" 6	"	III	S.W.	"	" 28	"	XI
S.W.	"	" 18	"	III	S.E.	"	" 1	"	XIII
S.W.	"	" 28	"	III	S.W.	"	" 12	"	XIII
S.E.	"	" 1	"	V	S.W.	"	" 24	"	XIII
S.W.	"	" 12	"	V	S.W.	"	" 6	"	XV
S.W.	"	" 24	"	V	S.W.	"	" 18	"	XV
S.W.	"	" 6	"	VII	S.W.	"	" 28	"	XV
S.W.	"	" 18	"	VII	S.E.	"	" 1	"	XVII
S.W.	"	" 28	"	VII	S.W.	"	" 12	"	XVII
S.E.	"	" 1	"	IX	S.W.	"	" 24	"	XVII
S.W.	"	" 24	"	IX	N.W.	"	" 18	"	XVIII
S.W.	"	" 6	"	XI					

The lines are all well cut out and blazed, and every precaution taken to see that the instructions were properly carried out. As the survey was not completed until the end of January, difficulty was experienced in some cases, in getting the posts firmly planted in the ground. The chainmen carried a double-bitted axe, and a hole for each post was chopper below the frost line.

The Township of Idington, as a whole, should be a good one from an agricultural standpoint. It is conveniently located, as the National Transcontinental Railway runs through the middle of it from east to west, and there are two stations within the township. Harty station is near the east boundary, and Opazatika station is near the west boundary. The whole township is gently rolling or level clay land, resembling that in the best parts of the Clay Belt. The lower portions are rather swampy, being covered with deep moss which retains the moisture. There is a great deal of fairly high land, however, sufficiently rolling to afford natural drainage. The Opakatika River runs through the north-westerly portion of the township. The banks of this river are low, and the land for a distance of half a mile to a mile back from the river is very wet, and so low and flat that drainage will be very difficult. The line between Concessions 14 and 15 runs through low swampy country for almost its whole length, and the portions of the township most suitable for immediate settlement are south of this line and east of the Opazatika River. The timber plan accompanying this report shows this fairly well, as the approximate location of the swampy portions and of the higher lands are shown in colors. A considerable portion of this township has been burnt over. These portions are also indicated on the plan referred to. The north-westerly portion of the township was over-run by fire about two or three years ago, and the timber is now beginning to fall. The burnt areas near the railway were probably burnt over during the construction of the railway, and are now covered with an almost impenetrable mass of windfalls. In Concessions 1, 2 and 3 there are some burnt areas which are apparently the result of earlier fires, as the timber is nearly all down, and much of it rotted away, so that these portions could be easily cleared. These areas are probably extensions of the large brule which is reported to exist further to the south, where fire is said to have swept a very large area some years before the railway was built.

The township is well timbered with spruce and balsam on the low ground, and spruce, balsam, poplar and birch on the higher areas. A large part of this township appears to have been burnt over ninety years ago, and is covered with a matured second growth. This old burn is fairly distinct from the rest of the town-

ship, and may be said to consist of that portion of the township previously mentioned as being best suited for immediate settlement, although it is difficult to lay down any exact limit, as portions of the original forest exist within the limits of this area, and evidences of this old fire were seen along the north boundary of the township. The timber growth on this area is fairly thick, but with very little spruce over nine or ten inches in diameter. The timber, however, is long and straight, and of excellent quality for pulpwood, of which there is a very large amount. On this area there is not so much underbrush, and the moss is not so deep. On the large swamp areas previously mentioned, the timber is mostly small, and in some places very sparse, there being several large areas of open marsh, particularly along the Opazatika River.

The Opazatika River is the largest stream, being about three chains wide, and flowing with a gentle current. There are also a couple of good sized creeks on the easterly side of the township which probably flow to the Kapuskasing River. There are several small lakes, the largest being Bear's Tooth Lake, which is about three-quarters of a mile long, with low swampy shores. There is one small island in this lake.

Game was very scarce. A few moose were seen on the high ground north of Harty station, but rabbits and partridge were conspicuous by their absence.

Enclosed herewith you will find field notes, a general plan mounted on cotton, a timber plan on tracing linen, and accounts in duplicate.

All of which is respectfully submitted.

I have the honour, to be, Sir,

Your obedient servant,

(Signed) JAMES S. DOBIE,

Ontario Land Surveyor.

The Honourable, the Minister of Lands, Forests and Mines,
Toronto, Ont.

Appendix No. 25.

REPORT OF SURVEY OF LADY EVELYN LAKE.

TORONTO, 26th September, 1916.

SIR,—We have the honour to submit the following report on the survey of the Mattawapika River and Lady Evelyn Lake and Islands therein, in accordance with instructions from your Department, dated 6th January, 1916.

Preparations for the work were made upon receipt of the instructions, such as getting equipment made and supplies ordered and shipped to Latchford, but owing to the unfavorable weather conditions in January, starting the work was somewhat delayed. On 24th January we went to North Bay, Temagami, and Latchford, to make arrangements for men suitable for this kind of work, and arranged for the transportation of supplies.

The party was in charge of Mr. A. T. Ward, O.L.S. Two surveyor's assistants were taken from Toronto, and the other necessary helpers were engaged as near the locality as circumstances would permit. Having organized our party to start inland from Latchford, where we were joined by the Crown Timber Estimator and his assistant, from Sudbury, we started from there on 1st February, proceeding up Bay Lake and the Montreal River, as far as the dam on the Mattawapika River. We were able to take a freight team with our supplies and outfit to this point, where our survey proper commenced.

We commenced our survey from a post planted by O.L.S. Blair, in front of Lot 9, Concession 5, Township of Barr, distant thirty-two chains west from the south-east angle of that lot, fixing the position of the Mattawapika Dam. The traverse lines were measured on the ice and were as close to the shore as practicable. Numbered pickets were put out at every five chains for the use of the Timber Estimator. Offsets to the shore were measured from these pickets, and a contour line, ten feet above the water level, was noted. Some difficulty was met with, owing to certain parts of the Mattawapika River being open. This was overcome by stadia readings. Station pickets were put at angles in the traverse lines and numbered consecutively. All previously established township outlines and points which could be found were connected with our traverse lines, and in addition, such mining claims, both on the main land and islands, as could be seen, were noted and connected with our survey.

We continued our survey up the Mattawapika River and Lady Evelyn Lake, in the aforesaid manner, and completed the work at the Falls, being the outlet of the Diamond Lake. on the 1st of April. During the last week in March we had almost continuous rain, which greatly impeded the field work, and was the cause of an early opening up of the rivers and creeks, thus bringing about a sudden termination of our survey.

Islands.

All islands were located and those of sufficient size to require it were traversed, and all were numbered consecutively from No. 1, with the prefix of the letter "E," in accordance with instructions. The designations of islands were marked on trees at prominent points. These trees were selected where possible above the contour line, also for their durability and prominence, and the description and position of each is shown in the field notes. In all, ninety-nine islands were surveyed, varying in size from one quarter of an acre to one hundred and eighty-five acres.

Contours.

Prior to leaving Latchford, we ascertained the elevation of the Montreal River, as indicated by the Government bench mark on the dam at Latchford.

We painted a bench mark on the rock immediately above the dam on the Mattawapika River, at an elevation of 950 feet above mean sea level, based upon the Government datum as previously ascertained at Latchford. The water level of the river above the dam was found to have an elevation of 938.46 feet.

Ten foot contour lines were fixed accurately where the shores were rocky or gradually rising, but on certain parts of the Mattawapika River where large areas of low swampy land interspersed with ridges and knolls were found, compass traverse lines were run in the swamps and the contour lines located approximately.

To obtain absolute results would require a much longer time and a larger party than we had at our disposal.

Timber.

We did not go into details as to the timber affected, as this was attended to by an official from your Department.

Water.

The area of the water in the Mattawapika River and Lady Evelyn Lake was found to be eighteen square miles and ninety-hundredths of a square mile. An additional area of seven square miles would be obtained should the waters be raised to the ten foot contour line, thus making a total twenty-five square miles and ninety-hundredths of a square mile .

In Willow Island and Suker Gut Lakes we have enlarged a geological map, scale four miles to the inch, to twenty chains to the inch, and find the area to be two square miles and ninety-three-hundredths of a square mile, but this is very approximate.

As before stated, we have no means of knowing to what extent this area would be increased by raising the water to the present contour line. By enquiry from the natives, we were informed that a considerable area of low land lies adjacent to these lakes.

The falls at the outlet of Diamond Lake was found to have an elevation of ten feet and two inches.

General Remarks.

The sudden and early breaking up of winter interfered with a detail survey of Willow Island and Suker Gut Lakes, which we contemplated, and had made preparations for, on receiving verbal instructions from the Inspector of Surveys from your Department.

Since the construction of the Mattawapika Dam, what was formerly known as Willow Island Falls, is now reduced to small rapids. These rapids are at the outlet of Willow Island and Suker Gut Lakes, and at the extreme west end of Lady Evelyn Lake. We were unable to make a survey of these waters owing to the breaking up of winter, and cannot tell to what extent raising the water would affect these lakes.

In the vicinity of the north-east angle of the township of Dane there were several mining claims staked out, and we understood that there has been some development work done. On account of the depth of snow, it was impossible for us to find out if there were any veins or development work done, which would be affected by the raising of the waters another ten feet. We thought it well to call attention to this fact, in case a claim might be made for damages sustained.

By travelling early in the morning and overland through the woods, we reached Latchford on April 5th, where the party was paid off and disbanded.

Accompanying this report is a plan on tracing linen, on a scale of twenty chains to the inch, in four sections, showing the existing shore line at the present water level, with contour lines about ten feet above that level, and traverse lines and station numbers thereon; also field notes on departmental paper, showing the

astronomical courses and lengths of all traverse lines with offset distances to the shores and contour lines; and field notes showing traverse lines of all the islands, numbered consecutively.

We have the honour to be, Sir,

Your obedient servants,

(Signed) SPEIGHT & VAN NOSTRAND,

Ontario Land Surveyors.

The Honourable the Minister of Lands, Forests and Mines,
Parliament Buildings, Toronto.

Appendix No. 26.

TORONTO, January 22nd, 1919.

To the Honourable the Minister of Lands, Forests and Mines, Ontario.

SIR,—I beg to submit herewith a report of operations conducted by this Department under the Northern and Northwestern Ontario Development Act—Amending Acts, 1916 and 1918.

LOANS TO SETTLERS.

Up to October 31st, 1918, a total of 1,839 applications for loans have been received, asking for a total amount of $699,755.00, an average of $380.51 per application. These were given careful consideration, and in all cases where *bona fide* settlers have shown actual need of financial assistance this Department has been pleased to co-operate, providing existing improvements to land warranted an advance, and it was clearly demonstrated the money was to be used to advantage in improving the property, or the living condition of the settler and his family.

A total of 1,305 loans have been issued to settlers, amounting to $407,286.00, the average loan being $312.10, and the development noted throughout the various districts in the way of increased land under cultivation, improved buildings, and larger holdings of live stock, would clearly indicate that good use has been made of the loans received and that settlers have been able to devote more of their time to work on their own lots in clearing up land, but the scarcity and high cost of labour for this class of work considerably retarded advancement along this line. The higher price of building materials, and live stock, prevented the new settler from accomplishing much over and above the result of his own labour.

Repayment of loans has been very satisfactory, in spite of adverse weather conditions for harvesting in some districts. This is evidenced by the fact that 90 per cent. of the interest payments have been received, and payments on account of principal, through payment of some loans in full, equal 99 per cent. of payments due.

LOANS TO CREAMERIES, ETC.

While a number of enquiries have been made and considerable correspondence carried on, the only loan issued of this nature, has been to the Sudbury Co-operative Creamery Co., Ltd., in an amount of $12,000.00. This was granted in July, 1918, and has apparently placed the institution on a good working basis; their operations having been carried on successfully during the year and the prospects are good for much better results in 1919, and consequently a greater benefit to the dairy industry, in the district served by the creamery. Other loans to creameries, cheese factories, and grist mills no doubt will be required, as there are a number pending, but matters are not yet in shape for the submission of formal applications.

In conclusion would direct your attention to attached detailed statement and would say that the general benefits derived by settlers from their ability to receive small loans from the Department on easy terms has often been expressed by individual settlers and is self evident from their improved conditions.

MEMORANDUM OF APPLICATIONS RECEIVED AND LOANS ISSUED TO OCTOBER 31ST, 1918.

APPLICATIONS.

Number of applications received	1,840
Amount applied for	$711,755 00
Average per application	$380 51

LOANS.

Number of loans issued	1,306
Amount granted	$419,286 00
Average loan	$312 10
Total acreage covered by liens	200,254
Total acreage improved land	27,585

NOTE.—Figures, except averages, include application for and loan of $12,000.00 to Sudbury Co-operative Creamery Co., Ltd.

REPAYMENTS.

Accrued interest due	$25,282 38
Accrued interest received	22,683 23
Payments on principal due	29,315 48
Payments on principal received	29,020 63

Total amount of loans and accrued interest outstanding, $392,864.52.

Yours very truly,

F. DANE,

Settlers' Loan Commissioner.

Appendix No. 27.

ALGONQUIN PARK, November 1st, 1918.

HONOURABLE SIR,—I beg to hand you my report for the fiscal year ending October 31st, 1918, under much happier conditions than my last report owing to the fact that the war that for years has been sapping the best life of the Empire is fast drawing to a victorious close.

We have had the usual staff of rangers, and they have been employed in various ways during the past year.

In November last you decided to have them take out a number of deer from the sections convenient to the railways, to be shipped to Toronto and other points to help out the meat supply. This was done, and several of our best men given the task of shooting and bringing to the railway the deer from different points. This represented a good deal of hard work, but our rangers did it creditably and some 650 deer were taken and shipped to Toronto and Hamilton. The net weight of the venison was 59,082 lbs., which sold for $5,090.34. The deer were taken mostly from near headquarters, Joe Lake and Brulé Lake sections, a few coming from the Canadian Northern in the northern section of the Park. The venison found a ready market and was, I believe, much appreciated both in Hamilton and Toronto. It was also decided to take out a quantity of fur. This was done mostly by the same men who took out the deer and a fine lot was sold, bringing $9,008.25. This was disposed of at public sale at the Parliament Buildings, Toronto, as usual, and was made up of beaver, otter, mink, marten, fisher and muskrat. As far as possible, the meat of the beaver, which by the way is excellent food, was saved and shipped to Toronto where it was in demand and brought a good price. Of this, 2,404 lbs. were shipped, the price received for which was $240.40.

In the spring it was decided to take out a quantity of mullet from the lakes near headquarters, where they had become very numerous, much to the detriment of the better fish, and five tons were taken out and shipped, bringing $129.20. I would recommend taking out a like quantity next spring from here and Joe Lake. The trout and bass are caught each year and the mullet left, with the result that they very much predominate and as they are spawn eaters they are under existing conditions a detriment.

It was also determined to take out a large quantity of hardwood in view of the fuel shortage, and in compliance with your instructions, camps were built, a drag-sawing machine and engine bought, and as many of the rangers as could be spared were allotted to this work. The wood was cut on one of the hardwood ridges west of Cranberry Lake and everything was cut, the brush and debris being well piled with a view to burning in the spring, when the whole will be cleaned up and seeded to hay for use of headquarters, etc. Several hundred cords of wood were cut by the rangers, when owing to the scarcity of men on the Grand Trunk Railway it was found necessary to detail our rangers to build the sidings required at several points in the Park for loading wood. This, of course, put a stop to the wood cutting. Three sidings were built, one at headquarters, one at Source Lake and one at Potter Lake, at both of which latter points the Government had given large contracts for taking out wood. By the time these sidings were completed, it was necessary for our men to return to their respective sections as the trappers had become busy, knowing the rangers were off their beats, and men

were hired to take their place in the wood-cutting camp and are continuing the work there.

I am glad to report there were no forest fires last year. Several were started along the railway, but with the telephone and the railway tank here at all times in readiness, they were gotten under control at once. The cleaning up along the railway also was a great assistance at these times, and no fires were allowed to reach the woods.

Owing to the fact that our rangers were otherwise employed, not many portages were cut or shelter houses built. One good shelter, however, was put up on the line of the Canadian Northern Railway near Francis Lake. There have not been any serious infringements of the law during the year, so far as the Park is concerned.

The old Indian, Francis Dufond, at Manitou lake died this fall, and I believe his old wife intends to move out to Mattawa as soon as the ice takes. This will leave the farm vacant, and as it is a rendezvous for the Indian trappers from Mattawa, I thought of stationing a ranger there. There are, as you are aware, a large clearing and several buildings on the farm, which belongs to the Government.

We have had a great many visitors to the Park, the Highland Inn and other hotels being filled to overflowing, and many had to be refused accommodation. They were mostly health seekers or parties who came for rest, many returned men among them who received genuine benefit from a stay here. With the war drawing to a close, we look for a return of our young men and sportsmen next year, who have been deterred from coming in the past on account of it.

A number of new leases have been granted and all the cottages on the lake were occupied. The boys' and girls' school camps, too, were filled up as usual, many of the parents staying at the Inn.

The Government did a lot of work on the road from headquarters to Big Island lake, and I trust this will be completed next year. It will be a stretch towards a trunk road through the Park, which will be a great convenience and afford much pleasure to visitors.

The fishing has been very good and some splendid trophies have been taken out by anglers. I hope some day to see a hatchery established here, not only to keep the Park waters replenished, but to supply the many lakes and rivers in the Province, especially to the east of the Park. A number of hybrids were taken this year, being a cross between the lake trout and the speckled trout, having the forked tail of the former and the red spots of the latter.

As there is likely to be a good demand for lumber of all kinds in the near future, I would strongly recommend some means being taken to manufacture the splendid hardwoods now mature on the limits acquired from the Munn people. There are vast blocks of the finest hardwood with an abundant growth of young timber coming on, and it would seem a great pity to let all this valuable timber decay and spread disease to the young growth. The woods would be benefited by a careful removing of the matured timber, and a large revenue could be derived from the same. The telephone line has proven a great benefit in many ways, especially in getting quickly to fires, also in the wood cutting operations, etc. It is a pity we cannot have further connection over the Bell line. At present we are confined to Orillia on the south and North Bay on the north. I am sorry to say work in this section, especially in the wood camps, has been very much handicapped by the outbreak of influenza, in some cases completely tying up the operations.

Game of all kinds is very abundant, and we expect a fine catch of furs during the coming winter and spring. Deer and moose are also plentiful, the number of the former taken out being from so small a section that it has had no effect whatever on the Park in general.

We have collected in rents here, $467.50; for licenses, $780.00; and for telephone, $70.43, making a total of $1,319.93.

These amounts do not include moneys paid direct to Toronto for rents, etc.

Yours very truly,

G. W. Bartlett,

Park Superintendent.

Honourable G. Howard Ferguson,
Minister of Lands, Forests and Mines,
Toronto, Ont.

Appendix No. 28.

Quetico Provincial Park.

Kawene P.O., Ont., Oct. 31st, 1918,

Sir,

I beg to submit my report for the fiscal year ending October 31st, as follows:

I found it very hard to get suitable men for rangers, owing to the scarcity of labour and the unusually high wages paid for lumbermen, rivermen, etc.

During the season the fire-rangers on Quetico Park were a separate unit from the Park-rangers inasmuch as they were under a chief fire-ranger. Two small fires occurred during the season, one on the island in Lake La Croix. It ran over about 25 acres, but being a light surface fire did practically no damage. The other occurred about the time of the Minnesota fire on Marion bay, Basswood lake, but was confined to about eight acres covered with poplar, birch, etc. It seemed indeed at that time that it might be very serious, as the smoke from the Minnesota fires south and east of us was very dense.

During the summer I had built at Eva lake a boat-house and also a shelter for our waggon there. At headquarters I built a canoe shed of sided timber 14 by 22 ft. This affords ample shelter for canoes in winter and for sleighs, waggons, etc., in summer.

Repairs were made to huts on Lacroix and Basswood lakes. Owing to the gradual decay of the dam on the "Dawson trail" at the outlet of Pickerel lake built about fifty years ago, I found it necessary to build a dam on Deux Rivieres, one of our main canoe routes, the water having become so low that it was nearly impassable. I had a road cut over-land from headquarters to the southwest corner of Eva lake, about 4½ miles distant, thus avoiding two small lakes which occasioned us much trouble, as the ice used to become unsafe on them when still good on the larger lakes. Many other trails, portages, and canoe routes were cut and improved.

Game is very plentiful in the Park, red deer, partridge, and beaver particularly having increased very rapidly.

The larger lakes in the Park abound in fish such as trout, pickerel, whitefish and pike, and in my opinion a considerable quantity of these might be taken without any detriment to the lakes whatever, thus helping to relieve the food situation.

The Shevlin-Clarke Lumber Co. of Ft. Frances will no doubt operate largely on their limits in the Park this season. Their operations will be closely patrolled by competent rangers. I am pleased to say that the officers of this company co-operate heartily with us in the matter of Park regulations.

I am in receipt of many letters of regret from persons who intended to visit the park during the summer, but who owing to war conditions had to forego the pleasure.

I have the honour to be Sir,

Your obedient Servant,

HUGH MCDONALD,

Superintendent.

HONOURABLE G. H. FERGUSON,

Minister of Lands, Forests and Mines,
Toronto, Ont.

Appendix No. 29.

COLONIZATION AND IMMIGRATION.

To the Honourable G. H. Ferguson, Minister of Lands, Forests and Mines, Toronto, Ontario:—

SIR,—I have the honour to submit the following report of the Bureau of Colonization for the fiscal year ending October 31st, 1918:

Number of letters received	5,008
Number of letters sent out	4,147
Northern Ontario literature circulated, including:— "A New Land Nearby", "Greater Ontario", "Ontario" Handbook, "Farming Opportunities in Ontario", "'Heaton's' Opportunities in Ontario", "Hints to Settlers in Northern Ontario"	17,656
Ontario Maps	1,236
Railway Certificates to settlers going to Northern Ontario	1,117

The work of this Branch for the year ending October 31st, 1918, was confined almost exclusively to advertising the great possibilities and opportunities in Northern Ontario held out to the prospective settler. About 5,000 people called at the office seeking information. The intention of most of them was to make the North their home after the war.

Although only about 380 settlers were placed in the different districts of the North during the year, this is a remarkable showing in view of the tremendous demand for all classes of people in every line of work throughout the war.

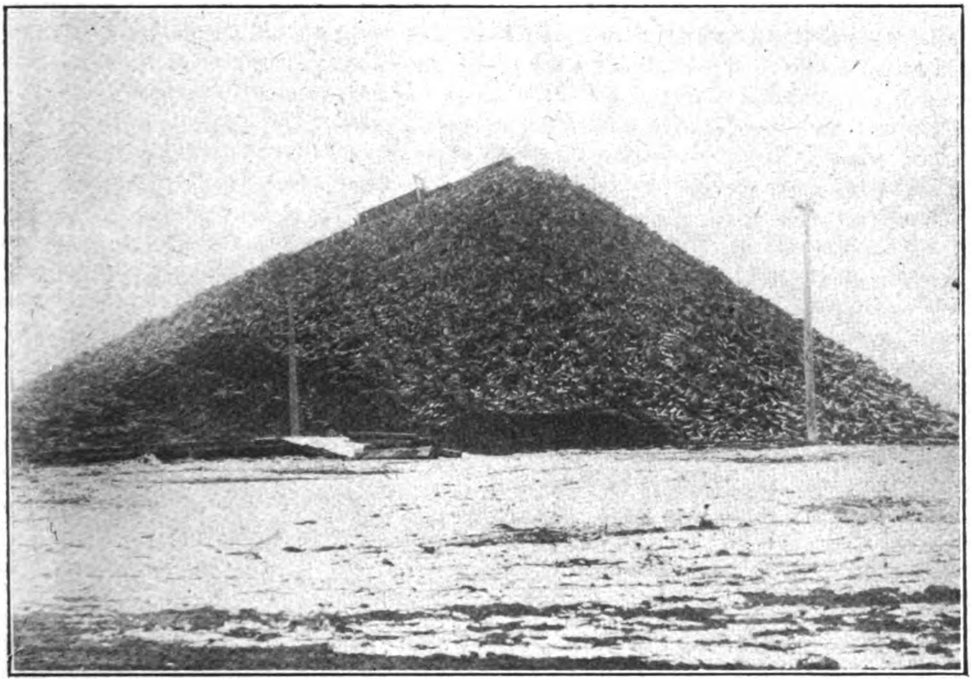
Our Northern Ontario exhibit at Toronto and at Ottawa was more largely attended than ever before. The one in Ottawa was considered by the Directors of the Central Canada Exhibition to be the chief feature of attraction. In addition

Breaking Land in Northern Ontario.

A Busy Haying Scene in Northern Ontario

to the fine varied display of the natural products of the North Country shown in the "Settler's Home" on the grounds, the Agricultural Department next door had, free to all, a moving picture show, exhibiting on the screen all the big industries in Northern Ontario, such as mining, lumbering and agriculture. They had also scenes of summer resorts, with lovely lakes and streams adjoining the hotels, and fish being drawn from the water by rod and line.

Now that the all-absorbing war is over, we look for a new influx of settlers into the gigantic land of great inducements entitled Northern Ontario. Its soil and climate are similar to Manitoba's; millions of fertile acres await the plough; immense profitable forests are ready for the axe and the lumber mill; great gold and silver and other mines are calling for further capital and labour; mighty water powers are proclaiming the coming day of utilized electric energy; and



$100,000 Pile of Pulpwood in Northern Ontario.

fisheries and hunting fields are offering profit and fascination to romantic minds; thousands of miles of railway and colonization roads interlace the land; big industries are already going; demonstration farms, with district representatives, are there to instruct and aid the settler; and cities, towns and villages, with schools and churches, have risen and continue to rise, as evidences of modern civilization.

That vast land is near, it is within the bounds of the Province of Ontario, and it is 330,000 square miles in area, six times larger than England. Let the prospective settler look at it and consider it well. It is worth while.

Since the preceding paragraphs were written the armistice has been signed, and as one of its indirect effects the immediate outlook in regard to colonization has been changed in a very marked degree. In every programme of reconstruc-

tion, in every discussion of the problem of demobilization, the subject of land settlement is given prominence. It is surely quite natural therefore that a Department such as this, whose work all along has operated so largely in this field, should feel that it has an important part to play in the reconstruction period that we are now entering upon.

In several ways provision has been made to strengthen the organization of the Colonization Branch for the work that lies ahead. In this connection it is worthy of note that the Prime Minister has appointed Brigadier-General R. Manley Sims, C.M.G., D.S.O., to fill temporarily the position of Agent General in the British Isles rendered vacant by the death of Mr. Richard Reid. General Sims, who has had a distinguished military career, is especially well fitted for useful service in this important position at the present time, when the London Office is proving of such great service to our Ontario soldiers overseas, and those who are returning. Mr. J. P. Young, who served in the C.E.F., and who has been assistant secretary to the Prime Minister, has been appointed publicity representative in the Agent General's Office, where his long experience as a newspaper man in Canada and England will be used to make Ontario better known through the press, and to advertise as widely as possible among Canadian soldiers and others what is being done for returned soldiers in Ontario, besides conveying to them information regarding land settlement, employment and re-establishment generally.

The Newcomers' Inn in Toronto, which has done such a splendid work in the past among newly arrived British immigrants, and which is largely maintained by the Ontario Government, and administered by the Salvation Army, has been recently completely renovated and refurnished in readiness for use when the immigration business is resumed. Arrangements are also being made with the Federal Government to obtain space for an Ontario Immigration Office in the great new Union Station at Toronto, which is nearing completion. Being right on the spot, this will enable us to serve the incoming immigrants to Ontario even better than was possible in our old office on Front Street, where so many thousands of British immigrants, who have since become prosperous citizens of our Province, received their first welcome to Ontario, and were sent to employment.

From these features of our present development it will be seen that the Colonization Branch anticipates taking no insignificant part in the upbuilding of our great and rich Province during the coming year of peace, repatriation, and reconstruction.

I have the honour to be, Sir,

Your obedient servant,

H. A. MACDONELL,

Director of Colonization.

Appendix No. 30.

Report on the Construction and Maintenance of Highways and Bridges Under the Provisions of the Northern and North Western Ontario Development Acts of 1912 and 1915.

(During the Season of 1918)

To the Honourable, the Minister of Lands, Forests and Mines:—

Sir,—I have the honour to submit the following report of the work done on the Construction and Maintenance of Roads and Bridges under the provisions of the above Acts, during the season of 1918:—

Operations were carried on in the Districts of Rainy River, Kenora, Port Arthur and Fort William, Sault Ste Marie, St. Joseph Island, Manitoulin Island, Algoma, Sudbury, Nipissing, Parry Sound, Muskoka and Renfrew.

In the Eastern part of the Districts the work throughout almost the entire summer season was considerably retarded by the damp or rainy weather in the Western Districts in the vicinity of Port Arthur. In the Valley of the Rainy River and in the District of Kenora the weather conditions were very favourable—comparatively dry weather. Labour, however, was difficult to procure in all the Districts, wages high and food supplies for men and teams expensive. Those engaged on the work were chiefly settlers where they could be procured. In the Agricultural districts during the periods of seeding, haying and harvesting, operations were suspended, in order to convenience the Settlers who wished to work on the roads. Very fair results were obtained throughout the season for the money expended. During the past season fewer miles of new roads were cut out than in previous seasons. Much of the work was confined to the re-construction and maintenance of old roads, by grading, improving and surfacing with either gravel or stone. The maintenance alone of trunk roads constructed within the last six years within the area covered by this season's work was no small task. Over 500 miles had to be looked after, dragged, re-surfaced in places and repaired. No new roads were cut out this season in advance of settlement; in many instances settlement is now considerably in advance of our roads. It was found, however, that in most instances the settlers were quite willing to forego all the comforts that might be derived from new roads during the war, but are living in hopes of relief as soon as conditions improve. During the past season, up to the 31st of October, Three hundred and forty-five thousand dollars was expended on the construction, repairing and maintenance of roads or bridges in the above mentioned Districts.

There is a growing demand by the settlers and business men in Northern Ontario for more roads and better roads. The earth or clay roads of the past will not satisfy them. Motor Cars and Trucks are rapidly becoming the vehicle of the day, and unless the roads are well surfaced with gravel or stone, and of a more permanent character, they will not meet the requirements. There is still, unfortunately, too little interest taken by the users of the Government Constructed roads in their maintenance or upkeep—and unless some legislation is passed in the near future, making it incumbent on the Municipalities through which these roads pass to contribute towards their maintenance they will become a considerable burden on the Province, or will soon become impassable in sections. The public all appreciate good roads, but are apparently not very willing in certain localities to con-

tribute towards their maintenance. Where good roads have been constructed in new districts, correspondingly good improvements on the land are being made by the Settlers. If, in the near future, there is any considerable immigration into Northern and North Western Ontario a considerable increase in road expenditure will be necessary in order to keep up to or slightly in advance of settlement.

During the past season considerable work was done on the North Bay and Bracebridge Trunk road. It has been partly completed to a few miles south of the town of Huntsville. A road was also re-constructed between Powassan Station on the Grand Trunk Railway West of Nipissing Village, a distance of over 10 miles. This road gives relief to a large settlement far distant from Railway facilities. Another season's work on the North Bay & Bracebridge Trunk Road will open a good motor car road betwween Old Ontario and the town of North Bay. It will take another season's work to surface with gravel all of the Trunk Road between the town of North Bay and Sudbury. Between Sudbury and Sault Ste. Marie there is still a gap of about 17 miles to be constructed between Cutler Station on Canadian Pacific Railway and Algoma Mills. When this is completed it will be possible to motor between Toronto and Sault Ste. Marie. During the past season a macadamised road was constructed between Copper Cliff and the Creighton Mine. On the Manitoulin and St. Joseph Islands operations were carried on on leading trunk roads. These are being surfaced with gravel and well graded and drained. In the District of Rainy River many miles of Trunk Roads were re-surfaced with gravel, new roads cut out and graded, and several miles of large drains constructed. The Trunk Road System was extended between Wabigoon and Oxdrift on Canadian Pacific Railway in the District of Kenora. In the Districts surrounding Port Arthur and Fort William several of the previously constructed Trunk Roads were surfaced or re-surfaced with gravel, and several short roads constructed or improved in the Agricultural sections. A mining road was cut out from Schreiber on the Canadian Pacific Railway North into a new Mining District on Big Duck Lake.

Following is a more detailed statement of the roads constructed in the various Districts during the season of 1918; also a statement of expenditures, and an approximate estimate of expenditure for the season of 1919.

I have the honour to be, Sir,

Your obedient servant,

J. F. Whitson,
Commissioner.

North Bay to Bracebridge Trunk Road.
Districts of Nipissing, Parry Sound and Muskoka.

Work was continued throughout the season on the North Bay and Bracebridge Trunk Road. It has now reached a point about 7 miles south of the Town of Huntsville. That part of the Trunk Road constructed from North Bay to Sundridge in previous years was gone over with the drag and re-surfaced in places where found necessary. Considerable gravel was used in re-surfacing and the ditches cleaned out. From Sundridge south to Burks Falls substantial new work was carried on. The distance between these two stations is about 13 miles; between Burks Falls and Katrine 4 miles; between Katrine and Emsdale 5 miles; from

Emsdale to Scotia Junction 2 miles; Scotia Junction to Novar about 6 miles; also about 7 miles of grading south of Huntsville.

The road between the Town of Powassan on the Grand Trunk Railway was re-constructed as far west as Nipissing Village, a distance of about 10 miles. Easterly, 7 miles of this road, leading out of Powassan was well graded and ditched and 2½ miles of it re-surfaced with gravel. The balance of the road, 3 miles, was graded in places where required and gravel placed on the worse parts. 20 culverts of corrugated iron and cedar were placed where required. The bridge across South River, known as "Healy's Bridge," was re-constructed with new stringers and new flooring. While this road had been constructed many years it was in very bad condition. It opens up a large settlement where there is consider-

Northern Ontario Exhibit at Ottawa.

able good farming land. It requires a further expenditure to complete this road, as it should be extended considerably west of Nipissing Village.

The road between North Bay and Burks Falls was continually dragged and kept in good repair. Maintaining this road cost considerable, as the distance from North Bay to Burks Falls is about 60 miles.

The road between Sundridge and Burks Falls was re-graded and gravelled in places. The road was also finished between Katrine and Emsdale and 1½ miles of it gravelled. From Emsdale to Scotia Junction, 2 miles, the road was widened out, ditched and graded, ½ mile of it surfaced with gravel. From Scotia Junction south to Novar, 6 miles, 3 miles was widened, stumped, graded and ¼ mile of it gravelled. At Katrine the bridge was reconstructed across Doe Lake outlet. South of Huntsville, beginning about 2 miles from Huntsville, 7 miles was widened, ditched

and graded and 2 miles of it gravelled. 60 corrugated iron culverts were placed where required during the season on this road. A deviation was made, commencing at a point about $1\frac{1}{4}$ miles west from Sundridge, on a road known as the "Distress Road," running to the village of Magnetawan.

On these various roads, $41,144.22 was expended.

ALGONQUIN PROVINCIAL PARK—DISTRICT OF NIPISSING.

During the season of 1916 a road was cut and graded in the Algonquin Provincial Park from the Algonquin Park Station, Grand Trunk Railway, northerly to Minesing Camp, a summer resort on Island Lake, a distance of 11 miles. The road became badly rutted owing to the fact that it had never been re-surfaced with gravel. The country through which this road passes is rolling, stony, and the soil a light sandy loam with small areas of clay soil in the swamps. When

A Temiskaming settler's first home.

the road was first constructed no gravel suitable for road purposes was available, the only road material used being a light loam. The road passes through a densely timbered section of the Park and the road originally was not cut out the usual width as it was only used as a tourist road; consequently there was little chance of the sun ever drying the road after the foilage came out. There is considerable traffic over this road during the tourist season, and also in the winter season hauling cord wood to the Railway Station.

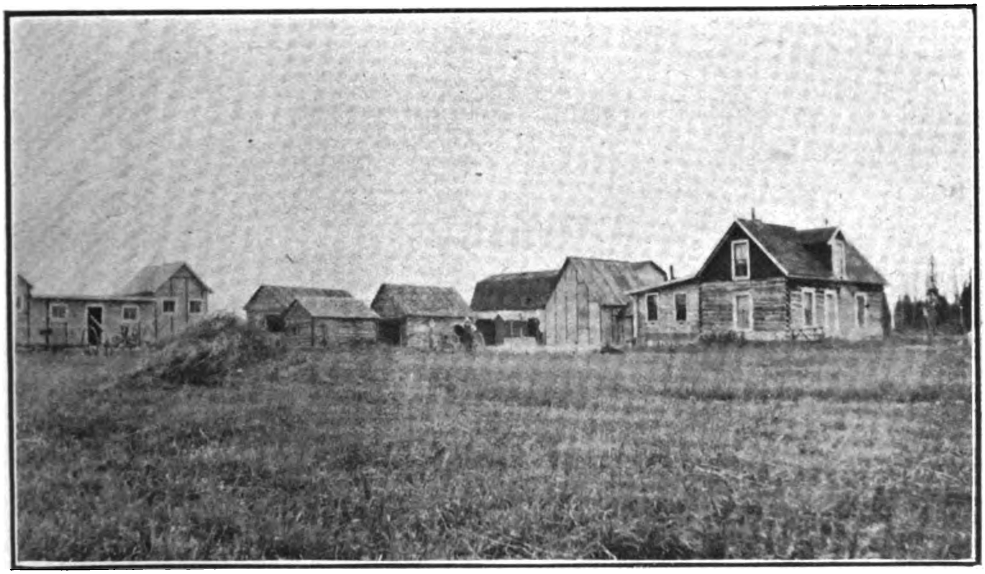
During the season of 1918 the road was widened out in places, re-ditched and re-graded for a distance of $8\frac{1}{2}$ miles, and parts of the road surfaced with gravel for a distance of $6\frac{1}{2}$ miles. Owing to the very wet season and the difficulty in getting gravel slow progress was made on this road. The road so far as it has been completed is in a first class condition and is a very beautiful drive for tourists through an almost virgin forest heavily timbered with maple, birch, beech and iron wood. The road for several miles back from the Railway Station can in the future

be used in connection with hauling of hard wood to the Station for fuel purposes. Thirty new culverts were placed in this road and 1,750 yards of gravel used in re-surfacing.

$13,722.79 was expended on this work.

North Bay to Sudbury Trunk Road—District of Nipissing.

Operations were started on this work early in January, 1918. Near Warren Station on the Canadian Pacific Railway the road was re-surfaced with gravel east and west of this point for a distance of 9 miles, west as far as Liberty's Bridge about 4½ miles and east about the same distance. 7,170 cubic yards of gravel were used in surfacing this section. About the same time a bridge was constructed over the Veuve River about ¾ of a mile west of Markstay Station. The bridge was built of cedar piles with white pine stringers and floored with tamarac planking.



A settler's buildings, Temiskaming.

A section of the road was re-gravelled near Wahnapitae Station on the Canadian Pacific Railway. The road from Wahnapitae Station to Sudbury was dragged and rolled with a 12 ton roller, after having it re-surfaced in places with crushed rock. During the summer season the road from North Bay to Sturgeon Falls was dragged. It was found, however, owing to the very wet season, difficult to keep this road in repair. That is, a section near Meadowside, where the road passes through flat country, the subsoil of which is quicksand. This section of the road will be required to be re-surfaced with gravel, which, unfortunately, cannot be found in the vicinity, before it will make a good permanent road. The road between Coniston Station and Sudbury has been dragged and rolled on two different occasions during the season and re-surfaced in a few places where it had become rutted.

Early in October a land slide occurred about 2 miles west of Warren on the bank of the Veuve River. About 260 feet in length of the road close to the bank dropped from 5 to 10 feet. This was owing to the washing out from under the

road bed of the quick sand. This had evidently been going on for years. The point is where the Venve River turns at a sharp angle and the current strikes the bank. This has been repaired and took 2,500 cubic yards of rock to complete the work. About 2 miles further west on the same road, where the trunk road crosses the Veuve to the south shore, an old bridge which was constructed about 15 years ago gave way, both abutments became rotten and the bridge collapsed. A new bridge with stone abutments is now under construction with a clear span of 60 feet.

A road was explored from a point about 3 miles north of St. Charles near the south east corner of the Township of Dunnet, north to Hagar Siding on the Canadian Pacific Railway, a distance of a little over 3 miles, and cut out for a winter road, but not graded.

$36,961.85 was expended on this road.

A view on the Sault Ste. Marie trunk road.

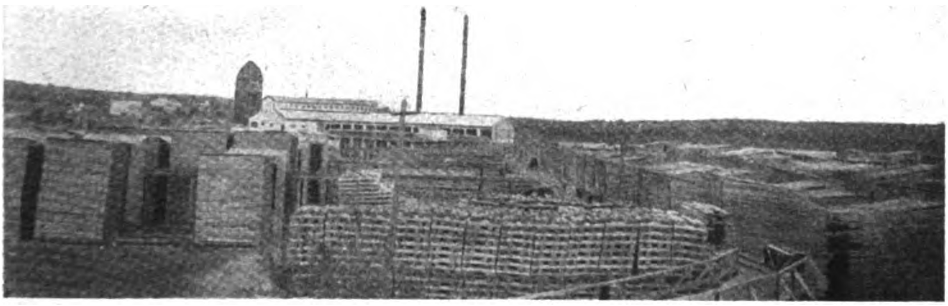
Copper Cliff and Creighton Trunk Road and Other Roads in the Vicinity of Sudbury.

Early in February operations were started on the road from the Town of Copper Cliff to the Creighton Mine, a distance of about seven miles. The work was carried on on this road throughout the winter and well on into August. A first class waterbound macadamized road was constructed between these two places. Ten thousand and six hundred cubic yards of crushed rock were used on the construction of this road. The rock was procured from the Canadian Copper Company's Crushers at Creighton Mine and hauled by teams over the road. Between Copper Cliff Station and Naughton Station on the Canadian Pacific Railway, Soo branch, the Trunk Road, which was built nearly 10 years ago, was improved, regraded in places and surfaced with gravel in places. This road is still, however, in bad condition in sections, and will require to be re-graded and gravelled the coming season.

The Trunk Road between Sudbury and Azilda on the main line of the Canadian Pacific Railway was dragged and improved where required. A new road was cut out from a point on the Canadian Northern Railway about a mile north of Milnet Station westerly to the Sellwood Mines near the Village of Sellwood. This road was cut out, culverts built, and made suitable for winter traffic. The road was constructed with a view to letting the people in the vicinity of the Sellwood Mines have access to the main line of the Canadian Northern Railway.

A waterway into West Shining Tree, gold mining district, was improved by the construction of 3 dams to regulate the water for navigation purposes.

$20,506.54 was expended on these roads.



Spanish River Lumber Company's mills and yard at Cutler, the western terminus of the Sudbury and Sault Ste. Marie trunk road.

SAULT STE. MARIE TRUNK ROAD, SAULT STE. MARIE TO ALGOMA MILLS—WORK PERFORMED DURING THE SEASON OF 1918.

On the above road, which has been constructed during the last six years, very little new work was required this season. The road has been surfaced with rock or gravel almost throughout the entire length, 102 miles, Soo to Algoma Mills. The road still, however, requires repairing and re-surfacing in places. During February and March of last season, 1,265 cubic yards of gravel was used in surfacing about 2½ miles along the Mississauga River in the Township of Thompson.

The balance of the season's work on this road was chiefly in maintenance or repair work from the Soo to Algoma Mills. Early in the season the western part of the road, from the Soo to Garden River was re-surfaced with crushed rock, 578 tons were required; the balance of the road was kept in repair by an overseer employed to patrol the road from end to end, make such repairs as were

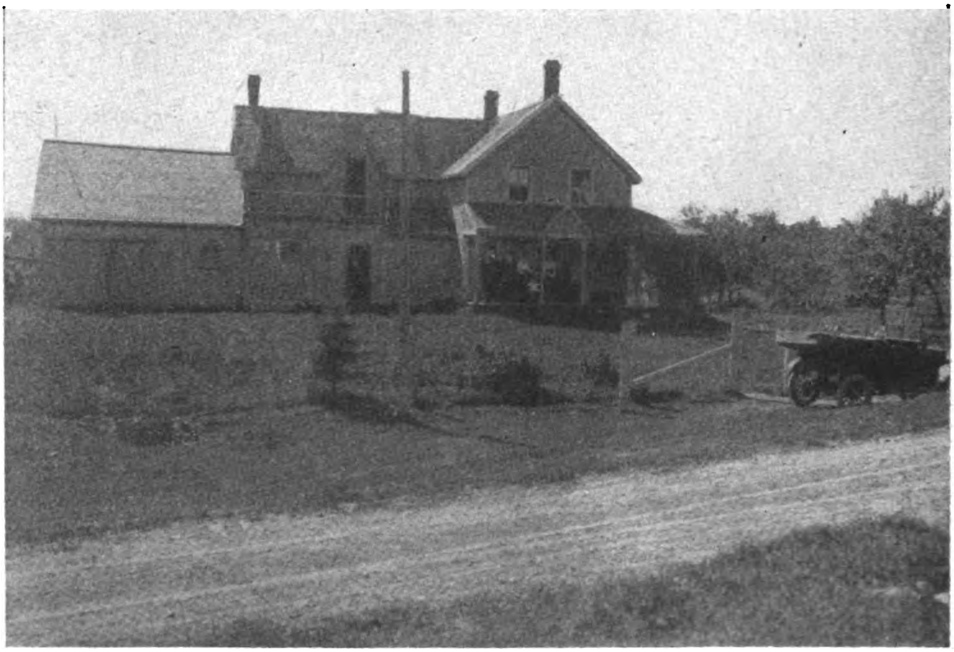
found necessary in the way of dragging, levelling, removing stones, filling ruts, opening up old ditches or culverts, repairing bridges, etc. This work was carried on very satisfactorily, so that during the season the road was kept in good condition. The amount of expenditure on this road during the past season was $10,331.67.

St. Joseph Island, District of Algoma.

Work Performed During the Season 1918.

Re-graded and surfaced with gravel	**14½ miles**
Ditches and offtake drains dug	**2¼ "**
Culverts constructed	**29**
Bridges constructed, 48′ and 25′ span	**2**
Roads brushed out	**2⅝ miles**
Roads dragged	**15 "**

Amount expended on above was $17,960.99.



A settler's home on St. Joseph Island, showing one of the trunk roads.

The work on the Trunk Road System as laid out on this island during the season of 1917 was continued.

The season was very favourable and good results were obtained notwithstanding the scarcity of labour during the haying and harvesting seasons. The Trunk Roads leading into the two Lakeport towns on the Island, Richard's Landing and Hilton are now in first class condition. There is still considerable work to be done in order to complete the Trunk Road System on this Island. Roads connecting the Trunk Roads leading into Richard's Landing and Hilton have yet to be constructed, and it will take another season's work to complete the system. The work that has already been done is of permanent character. The old existing roads had to be widened out, re-graded, ditched and surfaced.

Diversions were made in several places to avoid heavy grades. The road material found in different places throughout the island is of the very best quality. The roads constructed the previous year were dragged and a heavy roller passed over them so that now they are in A1 condition.

The following is a summary of the work performed on the island:

The 10th and 11th sideroad, Township of St. Joseph, across Concessions G. H. and I., 1¼ miles surfaced and across Concessions I. and K., 1 mile surfaced with gravel, and between I. and K. 5 turnouts gravelled; also 450 yds. gravelled in places across Concessions K., L., M., N., and O., and 100 rods of ditching done. The trunk road passing through the Village of Richard's Landing to the steamboat landing was well graded and gravelled. On Concession C. from the A. line easterly across lots 1 to 9 a distance of 2¼ miles surfaced with gravel; one cement culvert constructed, and the road ditched in front of lot 9. On the A. line from Concession D. north one mile and south 300 rods the road was surfaced with gravel and both sides of the road ditched for a distance of 350 rods. A stone culvert was constructed between Concessions G. and F., and a bridge constructed with 5 bents 48 ft. in length with stone abutments, and cedar and cement floor.

Six miles of road was graded and surfaced with gravel commencing at the Town of Hilton and extending easterly to the W. line and south along the W. line to Trainor's side-road. This road was well ditched, graded and gravelled. Sixteen hewed cedar culverts and one iron culvert were constructed. The right-of-way was widened and 4 offtake drains constructed.

On Concession U from the 5th side-road east the road was gravelled for a distance of 1¾ miles and for a distance of 350 ft. north on the 5th and 6th side-roads. Five culverts were constructed and a bridge at what is known as "Brown's Mill" was built of cedar, span 23 ft., cedar abutments filled with rock and planked with cedar.

MANITOULIN ISLAND.

Roads Constructed During the Season of 1918.

Number of miles of roads completed, graded and surfaced with gravel, 18½.
Number of miles of roads repaired, partly graded, and gravelled, 10.
Total number yards of gravel used in surfacing, 10,000.
Eighteen culverts constructed and five small bridges.
The amount expended on this work was $16,151.51.

Road construction work was commenced on Manitoulin Island early in July. The season was favourable throughout for working and good results were obtained notwithstanding the scarcity of labour. The only men employed on the work were settlers from the district.

Operations during this season consisted in re-constructing, grading, and surfacing with gravel part of the trunk road between the Town of Little Current and Gore Bay commenced in 1916, and the trunk road between the Towns of Little Current and Manitowaning, which passes through the Village of Sheguiandah. This road was commenced this season. The distance between the two towns is about 24 miles, and 8½ miles of this was completed this season. The road was straightened, brushed out and re-graded, ditched, and also surfaced with gravel. Ten miles of this road was brushed out or rather the road widened, ditched in places, and surfaced with gravel where it was most required. On the Little

Current and Gore Bay trunk road through the Townships of Howland, Allan and Gordon, 7½ miles was widened out, ditched, graded, and surfaced with gravel. Eight culverts and 4 small wooden bridges and 1 small stone bridge were constructed. Six thousand yards of gravel was used in surfacing this section of the road, and 4,000 yards on the Little Current and Manitowaning section.

On the Little Current and Manitowaning road 8 culverts were constructed. The worst parts of this road have been repaired. The very best of road material was used as it is found in great abundance in many places along this road. The wooden culverts were made out of cedar and also the abutments for bridges where stone was not used.

Remunerative winter work, Northern Ontario.

DISTRICT OF THUNDER BAY.

In the Vicinity of Port Arthur and Fort William.

Operations were started in this district about the middle of March, gravelling and re-gravelling parts of the International Highway between Port Arthur, Fort William and Pigeon River, locally known as the "Scott" Highway. The work was commenced on the eastern boundary of the Township of Neebing, a couple of miles east of the Prison Farm and portions of this road, which had not been gravelled the previous seasons, or where the gravelling done last season was not sufficiently heavy, were gravelled or re-gravelled this season, as far south as the International boundary at Pigeon River. The ditches, where they were found insufficient to carry off the water, were deepened and widened. Several new culverts were constructed. The worst grades on the road were cut down and at Horn Hill, where a mountain slide carried away part of the bed of the road into the Pigeon River, the road was re-constructed. Heavy rains of the previous

season late in the fall of the year caused considerable damage on this road. There were many washouts caused by the freshets coming down the hillsides from the north side of the road, the road being built through a valley, with mountain ranges in places rising to a height of over a thousand feet close to the road. Three small bridges, with 10-foot spans were constructed in the Township of Paipoonge, and one bridge, 32-foot span across the Slate River, all in the Township of Paipoonge.

After gravelling was finished, and while it was being done, the road was frequently dragged and kept in first class condition during the season. On this road there is now a great deal of automobile traffic from the northern part of the United States, Duluth, Superior City, Minneapolis and St. Paul and other cities. This road will soon become one of the most popular tourist roads in

A winter harvest, Northern Ontario.

Western Ontario, as well as in the northern part of the United States. The scenery along the road is very fine.

Oliver Road:

This road was re-graded, and surfaced with shale rock and gravel from Kakebeka to Murillo, about 9 miles. Six thousand five hundred yards of shale rock and gravel was used on this road.

Arthur Street Road:

This road was re-graded and gravelled from Kakabeka Falls easterly for 5 miles. Four thousand and two hundred and fifty-eight yards of gravel were used on this road.

Township of O'Connor:

Re-graded road between Concessions 6 and 7 across lots 1 to 6, 3 miles; also re-graded road between lots 6 and 7, across Concessions 6, 5, 4, 3, 4 miles, and the north half of 2, ½ mile. Put 3 culverts and 5 bridges on this road, one across Cedar Creek 22-ft. span, one across Tin Pail Creek, 16-ft. span, one across Cotton Wood Creek, 18-ft. span, 2 (across unnamed creeks) 16 and 18-ft. span, respectively.

Pearson Township:

Road between 3 and 4 Concessions, across lots 7, 8, 9 and 10 was re-graded. Two small bridges were constructed. On this road ½ mile of new road was graded and one mile old road re-graded.

Township of Conmee:

Between lots 4 and 5 across N. ½ of Concessions 1, 2, 3, 4, and the S. ½ of Concession 5 to Brule Creek, a distance of 4 miles. On this road hills were cut down, road widened, ditched and graded. Several small culverts were put in and about one mile road was gravelled, ¼ mile crosslaid, and bridge across Brule Creek repaired.

Silver Mountain Road:

This road from the Silver Mountain to Hymers was brushed out to a width of 50 ft., graded and ditched in places for a distance of 1½ miles. This road now connects up Stanley Village, Fort William and Port Arthur and surrounding country to the Village of Hymers.

Dawson Road:

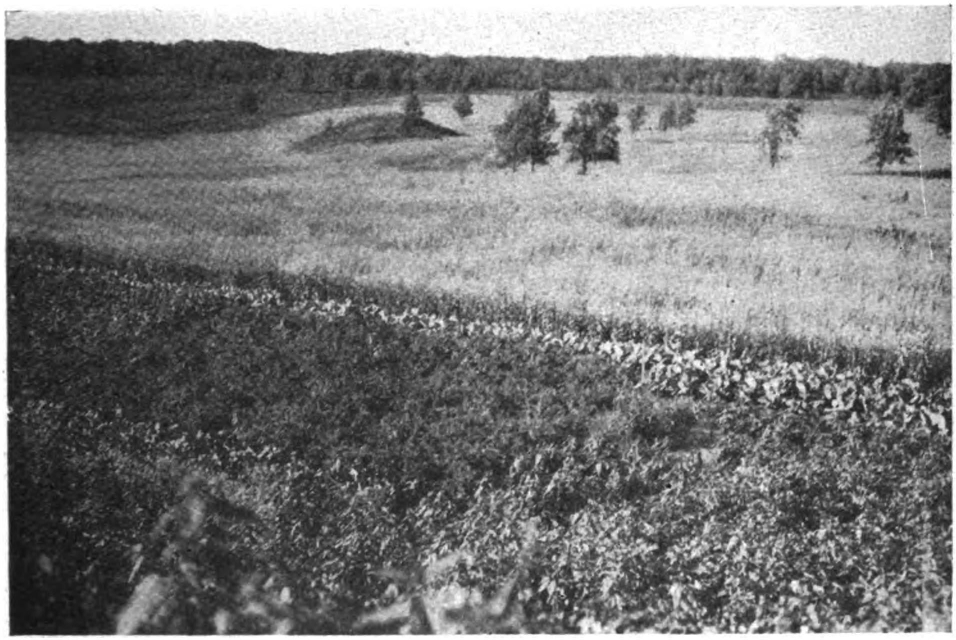
Commencing on the west boundary of McIntyre Township, operations were carried on northwesterly to Kaministiquia, C.P.R. Stations, 9½ miles. This road was re-graded and graded and culverts placed where required. A bridge 62 ft. long was reconstructed across a small creek flowing out of Mud Lake along the road. Several hills were cut down and gravel placed on the road where required. The road was gravelled in places for a distance of about 3 miles. Three small bridges with 12 ft., 10 ft. and 15 ft. spans were constructed and 76 wooden culverts placed.

$82,724.52 was expended in this district.

ROADS IN THE DISTRICT OF KENORA.

The work in this district was commenced early in June at Dryden on the Canadian Pacific Railway on lot 5, Concession 5, Township of Van Horne. From this point the work extended westerly to a point west of Oxdrift Station and east of Dryden commencing at Elm Bay, about 10 miles and extended from that point easterly to the Village of Wabigoon. This work was a continuation of the work of the trunk road system started in this section in 1917. While the season was very favourable for road work, owing to weather conditions, the difficulty of getting labour was very great and for that reason we were not able to carry out all the work laid out for the season. Near Dryden a diversion was made from the

old road passing through the Dryden Pulp & Paper Company's property. The diversion made improved the grade and shortened the distance. At this point there was an offtake drain dug into the Wabigoon River, 300 ft. From Dryden west to Oxdrift Station, about 7 miles, the old road was widened and straightened. The worst grades were cut down and depressions filled. The road was well ditched and graded. Corrugated iron culverts were placed where required and 2 small wooden bridges constructed on lots 6 and 8 in the 5th Concession, Van Horne. The road was surfaced with gravel for a distance of 5 miles. Forty-two corrugated iron culverts, ranging from 10 in. to 36 in. in diameter were placed where required and 3 stone culverts constructed. Swamps or muskegs were all well ditched and covered with corduroy where required and an offset ditch dug on lot 11, Concession 6 on said township ½ mile in length. The work extended about 4



A view of the prehistoric mounds on the banks of the Rainy River.

miles west of Oxdrift Station on the Canadian Pacific Railway. This portion of the road, however, has not been gravelled, but merely brushed out, ditched and graded. Owing to the long haul in getting gravel, it was deemed advisable to do this work in the winter season, as it could then be done at a much less cost.

The trunk road east of Dryden was constructed last year to a point on Elm Bay of Wabigoon Lake. From that point to the Village of Wabigoon, the old road was abandoned owing to the character of the country it passed through, it being a mere lumber road. A new road was located through a level country, the distance being about 6½ miles. This road was cut out and the brush piled, but no grading done.

In the Township of Mutrie, west of Eagle River, 16 miles west of the Town of Dryden, a small piece of work was done in front of lots 8, 9 and 10, Concession 1, about 1½ miles of this road was partly reconstructed.

The trunk road connecting the Towns of Kenora and Keewatin constructed 6 years ago was repaired and re-surfaced in places where it had become rutted and the dangerous crossing on the Canadian Pacific Railway almost in front of the Keewatin Station was improved and widened from 12 ft. to 32 ft. The grade on approaching to the railway was cut down, and a retaining wall of 150 ft. in length made of stone was erected, making this dangerous crossing safe.

$14,234.31 was expended on the work in this district.

A vegetable garden on the banks of Rainy River, showing one of the prehistoric mounds to the right.

ROADS CONSTRUCTED AND REPAIRED IN THE DISTRICT OF RAINY RIVER.

Number of miles of new and old roads worked on	71
" " new roads graded	15
" " old roads graded	22¾
" " road ditches dug	19
" " road cut out	14¼
" " roads grubbed	11
" " roads gravelled	27¾
" " tap drains dug	2¼
" " road dragged	94
culverts built	27
bridges built, 20-ft. span	1

Township of Spohn.

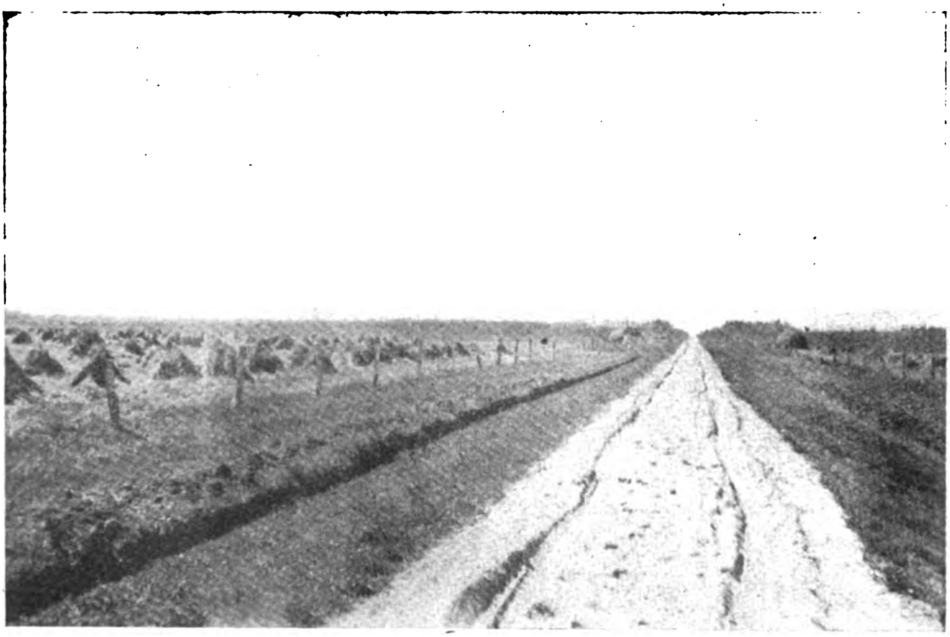
On road south of con. 3, in front of lots 5 and 6, 1 mile of new road was graded, of which ¼ mile was grubbed and ¾ mile gravelled.

On road between lots 4 and 5, across cons. 3 and 4, 1 mile was double ditched, ¾ of a mile single ditched, and 1¾ miles graded.

WILD LANDS RESERVE.

On road between secs. 29 and 30, 22 and 21, 13 and 14, and between 5 and 6, 4 miles of new road was graded, 4½ miles of ditches deepened, 1 mile of tap drain dug, 4,500 feet being between secs. 5 and 13 and the remainder north of sec. 5; 6 culverts were built on the above roads.

The above road in the Wild Lands Reserve and the Township of Spohn completes the grading of the highway from the Town of Rainy River to the Lake of the Woods and is the only highway in the Rainy River district connecting the highway system with the Lake of the Woods.



A field of grain in the Rainy River Valley near Stratton. Yield 100 bushels to the acre.

Township of Atwood:

On road east of Section 36, 1,400 ft. of road was double ditched and 4,000 ft. single ditched—(1 mile 120 ft.) One mile 120 ft. of the above road was graded. On road across river lots 1 to 23 and east of river lot 24, 2 miles of road was re-gravelled.

Township of Blue:

West of Sections 6, 7 and 18 and north of Section 7, 4 miles of road was single ditched and the grubbing widened out four feet. The above road was graded through its entire length for a distance of 4 miles. North of Section 8 the road was cleared, burnt and grubbed for a distance of ½ mile and 338 ft. and 2 culverts built.

Township of Worthington:

On the road south of Sections 32, 34, 35 and 36, one mile and 1,432 ft. regravelled. The road ditches were deepened for a distance of 2,186 ft, and 2 new culverts built.

Township of Pratt:

On road between lots 4 and 5 across Concessions 5 and 6 and across lots 3 and 4 north of Concessions 6, three miles of road was re-graded and brush cut and burnt on side of road for 2½ miles.

Township of McCrosson:

The road between lots 2 and 3 across Concessions 1 and 2 was re-graded for 2 miles and brush on the sides of the road cut for 2½ miles and partly burnt; ½ mile of this road was double ditched, and 3 new culverts built.

Township of Dilke:

The trunk road west of river lot 48 and across river lots 1 to 48 was re-gravelled for approximately 3½ miles, and one new culvert built.

Township of Morley:

On road west of Sections 18 and 19, one mile of road was re-gravelled. North of Section 19 one mile of road was gravelled and re-graded. North of Sections 11 and 12 about ½ mile of the trunk road was gravelled.

Long Sault Reserve:

On the trunk road south of the Canadian Northern Railway 3 miles of road was gravelled. The road on the west boundary of Section 3 was cleared and burnt for ½ mile, and grubbed and graded. On the road between river lots 30 and 31 and on the continuation of said road north of the Canadian Northern Railway 1 mile was cleared and burnt, and 1¼ miles grubbed, about 1 mile graded and ¼ mile of corduroy placed. On the road between Sections 11 and 12 and between river lots 44 and 45, 1⅔ miles were cleared and partly grubbed and burnt.

Township of Shenston:

On road east of Section 19, ¼ mile of road was cleared, burnt, grubbed and graded. On the road north of Sections 34, 35 and 36, 2¾ miles were cleared and partly burnt.

Township of Nelles:

Road between Sections 8 and 9, and between Sections 4 and 5 was graded for 1 mile, and ¼ mile gravelled and ditched, and 330 ft. of corduroy laid. On road between Sections 5 and 8, and 6 and 7, ¾ of a mile was graded and ½ mile gravelled.

Township of Barwick:

Across the Township of Barwick the trunk road was re-graded for 3 miles. The trunk road across river lots 34 to 44 was gravelled for 1 mile.

Manitou Indian Reserve:

The trunk road on the Manitou Reserve was gravelled for ¼ mile, and 3 miles was re-graded.

Townline of Mather and Kingsford:

On the road across Concessions 4, 5 and 6 and on correction line on the north boundary of Kingsford, 3 miles of road was burnt and grubbed, 2¼ miles of side ditches were built, 2 miles of road put up with slushers and horse grader, 1 mile of corduroy laid, 1 mile of tap drain dug and 6 culverts built, and 1 bridge built with a span of 20 ft.

Township of Potts:

On the north end of road between lots 2 and 3 across Concessions 1, 2, 3, 4 and 25 chains on the south of Concession 5, 1 mile and 1,560 feet were cleared and partly burnt. Half mile of this road was single ditched, ½ mile of corduroy laid, and 3 miles grubbed and 1½ miles graded, and 4 culverts built.

A view on the banks of the Rainy River.

Township of Lash:

On road north of Sections 25 and 26, ½ mile of road was re-graded over rock. On road north of Sections 25, 26, 27 and 28, 3 miles of road was gravelled.

Township of Carpenter:

On road east of lot 1, across Concessions 3, 4, 5 and 6, 3½ miles of road was re-graded.

Township of Devlin:

On the road north of Sections 30 and 29 and east of Section 29, and north of Sections 21, 22, 23 and 24, 4½ miles of the trunk road was re-gravelled. On road north of Section 20, ½ mile was gravelled. The road east of Section 3 was re-graded for ½ mile.

Township of Woodyatt:

The river road across lots 28 to 47 was re-graded for 2½ miles. The above road was gravelled excepting across lots 31 and 32 for 2¼ miles. The road east of river lot 17 and Section 34 was re-graded and gravelled 2 miles.

Township of Kingsford:

Road between lots 4 and 5 across Concession 2 was grubbed, ditched and graded 1 mile.

Township of Miscampbell:

The road across lot 4 south of Concession 1, and between lots 4 and 5 across Concession 1 was cleared, grubbed and single ditched for 1¼ miles. Twelve hundred feet of tap drain was dug and 3 culverts built.

$69,480.59 was expended on the work in this district.

To the Honourable G. H. Ferguson, Minister of Lands, Forests and Mines, Ontario.

Sir,—I have the honour to present to you the report of the road and bridge construction and improvement carried out in the District of Temiskaming and that portion of the District of Algoma, in the vicinity of Hearst, which is at present the northern terminus of the Algoma Central & Hudson Bay Railway, during the year ending October 31st, 1918, under the provisions of the Act of 1912 and its subsequent amendments for the Development of Northern and North-western Ontario.

For the purpose of carrying on the work the area described above is divided into sub-districts designated by the centre from which the work is locally directed as follows; the Englehart, Matheson, Cochrane and Hearst districts. In addition there was work done upon the roads independently of these local headquarters and these are reported upon separately.

Whether or not, it is the fear that the Government will curtail the expenditure of money on roads and bridges in organized townships and that consequently taxes will be levied locally for such and similar expenditures, or, for some other reason or reasons few steps are being taken to form municipal organizations in Temiskaming. The Township of Teck in the Kirkland Lake Mining District has taken steps to organize, the residents of the Township of Playfair near Matheson are discussing it seriously and the Townships of Savard and Marter near Englehart have organized under the Statute Labour Act to assist in the construction and maintenance of their roads, but outside of these townships I have heard of no move being made in the direction of assuming the burden of their own public works.

The season in Temiskaming was rather unfavourable for the carrying on of road work, particularly in the latter portion of it. It rained rather frequently during the fall, retarding road construction.

Attached is a statement giving in detail the work accomplished, the expenditures being shown in the statement of the Secretary.

I have the honour to be, Sir,

Your obedient servant,

C. H. Fullerton,

Acting Director Northern Development Branch, Temiskaming District.

Toronto, Ont., October 31st, 1918.

COCHRANE DISTRICT.

Township of Brower:

Road between Concessions 4 and 5 across Lots 1 and 2, one mile cut, burned and grubbed.

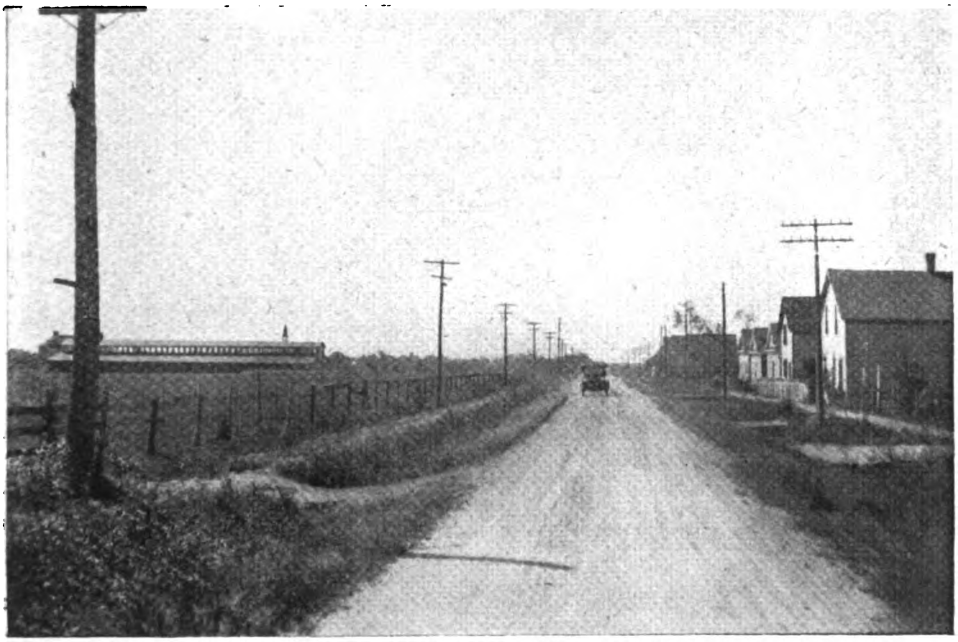
Road between Concessions 2 and 3 across Lots 9 to 12, two miles grubbed and sideditched.

Road between Lots 6 and 7 across Concessions 4 and 5, ¾ mile sideditched.

Road between Lots 10 and 11 across Concession 5, ¾ mile sideditched.

Road along Canadian Government Railway across Lot 7; ⅓ mile sideditched.

Road between Lots 8 and 9 Concession 5, 1½ miles sideditched.



The Fort Frances and Rainy River trunk road through the town of Rainy River.

Township of Calvert:

Roads between Lots 4 and 5 across Concessions 2 and 3, between Concessions 2 and 3, across Lot 5 and between Lots 5 and 6, across Concession 1, one mile sideditched.

Road between Concessions 4 and 5 across Lots 1 and 2, ½ mile graded and 400 ft. sideditched.

Road between Concessions 1 and 2 across Lot 9, ½ mile cut and burned.

Road between Concessions 4 and 5, one mile cut, burned and grubbed across Lots 4 and 5.

Roads between Lots 4 and 5, across Concessions 2 and 3 and between Concessions 1 and 2 across Lot 5, ½ mile grubbed and 1½ miles sideditching.

Road between Concessions 4 and 5, across Lot 3, 1,000 yds. cut, burned and grubbed.

Trunk Road, Iroquois Falls to Porquis Jct. 1 culvert built, 1 mile graded, 51 chains ditched, 47 chains repaired and 53 chains gravelled.

Road between townships of Calvert and Clergue across Concession 1, 3 culverts repaired, 13 chains gravelled and 122 chains ditched.

Township of Clergue:

Road between Concessions 4 and 5 across Lots 3, 4 and 5, 1½ miles cut and burned.

Township of Clute:

Road between Concessions 4 and 5, across Lots 26, 27 and 28; 20 chains grubbed and 3 chains ditched.

Large game in the District of Rainy River.

Roads between Concessions 8 and 9, across Lots 14, 15 and 16, and between Lots 12 and 13 across Concession 7, 27 chains ditched.

Road between Concessions 10 and 11, across Lots 1 and 2, 1 bridge and 1 culvert built and 5 chains graded.

Road between Lots 12 and 13, across Concessions 2 to 7, 2 culverts built, 48 chains ditched, 84 chains graded and 7 chains repaired.

Township of Glackmeyer:

Road between Concessions 6 and 7, across Lot 12, 18 chains repaired.

Road between Lots 24 and 25, across Concession 2, 47 chains gravelled, and 11 chains repaired.

Road between township of Glackmeyer and township of Clute, across Concessions 7 to 12 inclusive, 3 bridges and 7 culverts built, 18 chains ditched, 27 chains repaired and 2½ miles graded.

Roads between Concessions 4 and 5, Lots 19 to 23 inclusive, and between Lots 18 and 19, Concessions 2 to 12 inclusive, 7 culverts built and 3 repaired, 16 chains grubbed, 22½ chains ditched, 145 chains graded and 360 chains repaired.

Township of Lamarche:

Road between Concessions 5 and 6, across Lot 4, 10½ chains ditched.

Road between Lamarche and Glackmeyer townships across Lots 5 to 9 inclusive, 22 chains cut and burned and 61 chains gravelled.

Road between Lots 8 and 9, Concession 6, 60 chains repaired and 67 chains gravelled.

Road between Lots 6 and 7, Concession 5, 32 chains gravelled.

Road between Lots 5 and 6, across Concessions 7 and 8, 69 chains repaired and 60 chains gravelled.

Road between Lots 2 and 3, across Concession 6, 5 culverts built and one repaired, 1 mile ditching and 3 chains of repair to road.

A field of corn in the District of Rainy River, Township of Curran.

Township of Leitch:

Road between Concessions 4 and 5, across Lot 2; 25 chains grubbed.

Road between township of Leitch and Blount, across Concession 6, 1 culvert built and ½ mile grubbed and ditched.

Township of Newmarket:

Trunk Road on line between Calvert and McCart, across Concession 6 and along T. & N. O. Railway from mileage 231.5 to mileage 236 in the township of Newmarket, 4½ miles cut and burned, 5 miles grubbed, 3 miles ditched and a small amount of repairs.

Township of Shackleton:

Road across Lot 21, Concession 12, 23 chains cut, burned and grubbed.

Road across Lot 23, Concession 12, 20 chains grubbed.

ENGLEHART DISTRICT.

Township of Armstrong:

The road on Lot 6 Concession 4 drained and gravelled and a culvert was built on it.

The boundary road between Armstrong and Beauchamp was improved by replacing 2 trestle bridges with culverts and fills in Concessions 4 and 5. In Concession 6, ½ mile of new road was cut out and made ready to grade the remaining ½ mile being grubbed 15 ft. in width.

Townships of Beauchamp and Henwood:

The boundary road between these townships was improved by replacing 2 bridges with culverts and fills.

Township of Catharine:

The road between Concessions 1 and 2, across Lot 12, was stumped and several culverts built.

Township of Chamberlain:

The roads between Concessions 4 and 5, across Lot 11 and between Lots 10 and 11, across Concession 5, were re-cleared and drained, 7 culverts built and are now ready for grading.

The road between Concessions 5 and 6 from centre of Lot 8 to west side of Lot 10, was cleared and grubbed ready for grading.

The road between Concessions 3 and 4, across Lots 7 and 8 was cut and logged.

The road between Concessions 1 and 2 was improved as follows: stumped and grubbed across Lot 8 and cut out, stumped and grubbed across Lots 9 and 10, 14 culverts were built and the road ready to be graded.

Township of Dack:

A new road was made in Concession 6, across Lots 1 and 2, along the T. N. O. Railway and thence West to the West side of Lot 2, the road was drained and made ready to grade, 12 excellent cedar culverts were built upon it.

The road from Englehart to Charlton across Lots 1, 2, 3, and 4, Township of Dack and across Lot 12 Township of Evanturel, between Concessions 5 and 6, was dragged and repaired.

Temporary repairs were made upon the roads between Lots 2 and 3, Concession 6.

The road between Dack and Chamberlain townships was repaired for 2 miles across Lots 9 ,10, 11 and 12.

The road between Lots 8 and 9, across Concession 6 was repaired and a culvert built on it.

Opposite Lot 9 between Concessions 5 and 6, a culvert was built and the approaches improved.

The road between Concessions 4 and 5 was graded across Lots 1, 2, 3, and 4 and drained across Lot 4.

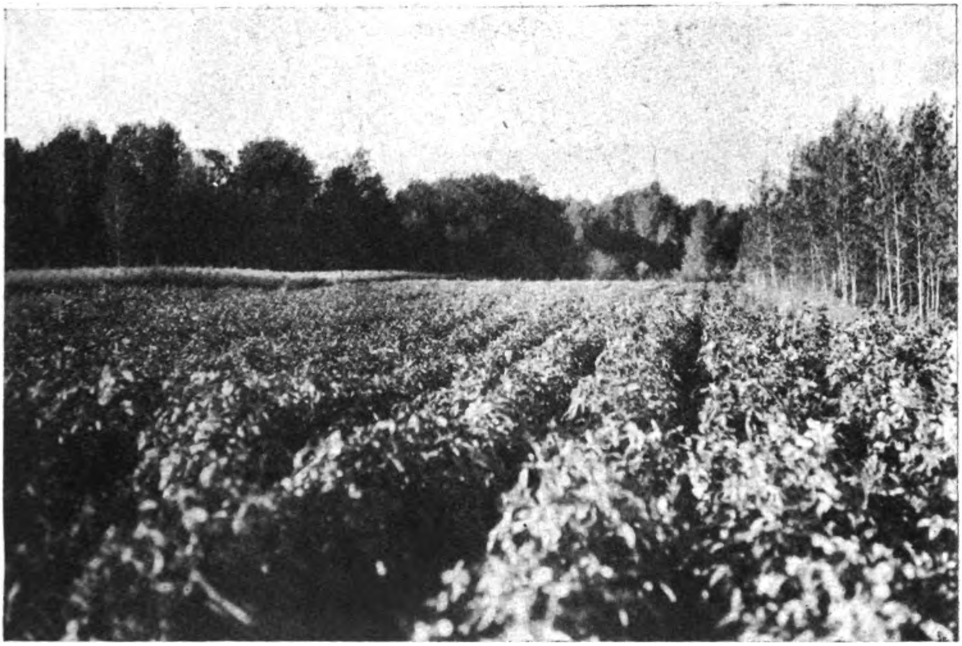
The road between Lots 2 and 3 was stumped ready for grading and 4 culverts were built.

Three hills on the road across Lots 12 in Dack and 1 and 2 Robillard between Concessions 3 and 4 were reduced.

Township of Evanturel:

The road between Concessions 1 and 2 was drained and graded across Lots 1 and 2. The road between Concessions 5 and 6 was repaired across Lots 7 and 10 inclusive.

The road between Concessions 3 and 4; to prevent the flooding of Lot 6, Concession 4 by road drains, a ditch across this Lot was undertaken to carry the water to a suitable outlet.



Potato field in the Rainy River Valley.

The road between Evanturel and Ingram across Concessions 2 and 3 was repaired, the drainage was improved and 3 culverts built.

Township of Lorrain:

The roads between Lots 12 and 13 across Concessions 3 and 4, for a distance of 1½ miles, was stumped, grubbed, drained and graded and 7 culverts built.

Across Lot 12 Concession 5 the road was drained, a culvert built and 50 yds. of gravelling done.

Township of Marter:

Road between Lots 10 and 11, Concession 1, approaches to bridge over Crocodile Creek were improved.

Road between Lots 6 and 7, Concession 1, repaired a distance of 400 yds.

Road between Lot 5, Concession 4 cut out 40 ft. wide, stumped 12 ft. wide and 1 culvert built.

Road between Concessions 3 and 4 was drained by conveying water to a suitable outlet, instead of flooding private land.

On road between Lots 2 and 3 across Concession 1, Marter, and Concession 6 Evanturel, ¾ of a mile was stumped and graded, 100 yds. of corduroy laid and a hill reduced.

Typical view of one of the back townships in the District of Rainy River.

Township of Marquis:

Road between Lots 8 and 9 across Concession 1, stumped, grubbed and drained, 8 culverts and 1 bridge, 20 ft. span, built and 100 yds. of corduroy laid.

Township of Otto:

Road across Lots 3 and 4, between Concessions 5 and 6 stumped, sidebrushed and drained, 4 culverts were built.

Township of Pacaud:

A road was built from the new railway station at Boston Creek to connect with the road which leads to the working properties.

Road across Lot 6, Concession 6 was cut 40 ft. wide and stumped 20 ft. wide, 2 culverts were made and the road graded.

Road between Concessions 4 and 5, a bridge of 30 ft. span was built and the approaches graded.

On road between Lots 4 and 5, a bridge of 40 ft. span was reconstructed and the approaches improved in Concession 1, and the ditches re-opened and the road graded across Concession 2.

Township of Robillard:

Road between Lots 8 and 9 across Concession 5, ½ mile logged, and stumped 30 ft. wide.

View on the Rainy River and Spohn trunk road.

Township of Savard:

Road between Lots 2 and 3 across Concession 1, ½ mile cleared and stumped 30 ft. wide.

Townships of Robillard, Truax, Tudhope and James:

The road from Charlton to Englehart runs through these townships and it had fallen so badly into disrepair that travel over it was exceedingly difficult and unsafe. General repairs were made upon it for a distance of 16 miles. Rock and boulders were removed, the drainage vastly improved, 26 culverts were made, 1½ miles were gravelled and ½ mile of corduroy laid and covered.

HEARST DISTRICT.

Township of Casgrain:

Road on line between Lots 24 and 25 across Concessions 1, 2, and 3, general repairs.

Road on line between Concessions 2 and 3, across Lots 25 and 26, general repairs.

Road on line between Concessions 4 and 5, across Lots 20, 21 and 22.

Road on line between Lots 18 and 19, on part of Concessions 1, 4, 5 and 6, grading and building culverts.

Road on line between Concessions 2 and 3, across Lot 24 and part of 23. ditching.

Road on line between Concessions 4 and 5, across part of Lots 18 and 19, ditching.

Road on line between Lots 18 and 19, across Concessions 4 and 5 and part of 6, ditching.

Township of Hanlan:

Road across Lots 23 to 28 inclusive, Concession 2, grubbing and burning.

Road on line between Lots 18 and 19, across Concession 2 and part of Concession 1, grubbing and burning.

Road across part of Lot 20, Concessions 1 and 2, and Lots 21 to 23, Concession 2, ditching.

Road on line between Lots 18 and 19, across Concession 2 and part of Concession 1, ditching.

Township of Kendall:

Road between Lots 24 and 25, across Concessions 11 and 12, general repairs.

Road across part of Lots 21 and 22 and all of Lots 23 and 24, Concession 10, on East bank of Mattawishkwia River, grubbing and burning.

Road on line between Lots 24 and 25, across Concession 9 and part of 10, grubbing and burning.

Road between Concessions 9 and 10, grading and building culverts.

Road on East bank of Mattawishkwia River; temporary bridges on line between Lots 24 and 25.

Road on Lots 25 and 26 and part of 27 and 28, between Concessions 9 and 10, ditching.

Road on line between Lots 24 and 25, across part of Concessions 9 and 10, ditching.

Road on part of Lots 23 and 24, on East bank of Mattawishkwia River, ditching.

Road between Townships of Kendall and Way, across Lots 1 and 5 inclusive, grubbing and ditching.

Road across Concessions 8 to 12 inclusive, general repairs.

Road across Concession 7, grubbing, burning and ditching.

Trunk Road, regrading, ditching, repairing culverts, across townships of Kendall, part of Way and Lots 12 to 16 Hanlan.

Township of Owens:

Road from sand pit new mileage 80½ Canadian Government Railway, to North Boundary of Owens township, 65½ chains cut, 14½ chains graded, 8½ chains crosslaying.

Draining the Swamp Lands in the District of Rainy River, through the Wild Land Reserve.

Road between Lots 24 and 25 from boundary between townships of Owens and Williamson, 2¼ miles cut, 2 miles graded, with crosslaying where necessary.

Road between Concessions 16 and 17, 21 chains cut, burned, and grubbed, 2½ chains graded, 7¼ chains crosslaying.

Road between Concessions 14 and 15, 44 chains slashed, 27 chains stumped and grubbed.

Road between townships of Owens and Williamson, across Lots 25 and 26, ½ mile cut, 26 chains road completed, 10 chains crosslaying, 5 chains grading.

A Railway spur was run off the Canadian Government Railway at about mileage 80½, for the purpose of settlement in Owens township.

Township of O'Brien.

Road between Lots 12 and 13, cutting, grubbing and burning, 1 mile to line between Concessions 8 and 9.

Road between Concessions 8 and 9, cutting, grubbing and burning across Lots 1 to 25 inclusive and cutting and burning across Lot 26.

Bridge at "Notch," near mouth of Montreal River, Temiskaming.

Road between Concessions 12 and 13, from line between Lots 16 and 17 to line between Lots 10 and 11, cutting, grubbing and burning ditching and crosslaying; and cutting, grubbing and ditching across Lots 15 to 18 inclusive.

Road between Concessions 10 and 11, from line between Lots 24 and 25 to line between Lots 12 and 13, cutting, grubbing, burning, ditching and crosslaying.

Road between Concessions 14 and 15, across Lots 19, 20 and 22, draining roadway and building culverts.

Road between Lots 18 and 19, cutting, grubbing, ditching and crosslaying, across Concessions 10, 11 and part of 12.

Road between Lots 6 and 7, across Concession 9, cutting and grubbing, and across Concessions 5, 6, 7 and 8, cutting and burning.

Road between Lots 22 and 23, cutting, grubbing, burning, ditching and crosslaying across Concessions 11 and 12.

Road between Concessions 10 and 11, cutting, grubbing and burning across Lots 1 to 8 inclusive.

Roads between Lots 24 and 25, across Concessions 7 to 10 inclusive, and between Concessions 6 and 7, across Lots 25, 26, 27 and 28 to Woman River, cutting, grubbing and burning.

Road between Lots 12 and 13, cutting, grubbing and burning across Concessions 5 to 15 inclusive.

Road between Concessions 6 and 7, cutting, burning, and grubbing across Lots 1 to 12 inclusive.

Road between Lots 6 and 7, cutting, grubbing and burning across Concessions 10 to 14 inclusive.

Road between Concessions 12 and 13 across Lots 1 to 6, cutting, grubbing and burning.

Road between Concessions 14 and 15, across Lots 12 to 20 inclusive, cutting, burning and grading.

Trunk road along North side of railway, across 8 to 26, repaired, drained, corduroy laid and culverts built.

Boundary road between townships of O'Brien and Fauquier, cut, grubbed and burnt across Concessions 5 to 12 inclusive.

In addition to the above, the following were built, a bridge on Lot 19, on the line between Concessions 12 and 13, 10 temporary bridges and 28 culverts.

The work of bridging the Kapuskasing River has been undertaken, contracts were let for the delivery of two steel spans, one 80 ft. and the other 120 ft. in length, and four masonry abutments have been constructed to support the steel spans.

MATHESON DISTRICT.

Township of Beatty:

Road between Lots 9 and 10, Concession 1, 1 mile cut, stumped and gravelled.

Road between Lots 10 and 12, ¾ mile cut and logged in Concession 1, 2 miles cut, stumped and grubbed in Concessions 4 and 5.

Road between Concessions 2 and 3, 40 chains stumped and grubbed across Lot 5 and part of 6, 1½ miles regraded across Lots 11, 12 and 13.

Township of Benoit:

Road between Concessions 2 and 3, ½ mile stumped and grubbed across Lots 4, 5 and part of 6.

Road between Lots 8 and 9 across Concessions 2 and 3, 6 culverts and 1 bridge, 30 ft. long, built, and 2 miles stumped and grubbed.

Road between Concessions 1 and 2, 3 miles stumped and grubbed across Lots 3 to 8 inclusive, 20 chains stumped, 5 chains graded and 500 cu. yds. of fill on approaches to bridge on Lot 9.

Township of Bond:

Road between Concessions 2 and 3, across Lot 2, 30 chains stumped and grubbed and 10 chains graded.

Road between Lots 2 and 3, across Concession 5, 20 chains stumped and grubbed and 44 chains graded.

Road across Lot 2 Concession 6, 10 chains cut stumped and ditched.

Township of Bowman:

Road between Lots 4 and 5, 6 chains ditched, 5 chains gravelled.

Road across Concession 4, Russel Creek bridge 30 ft. span repaired, Concession 5.

Road between Concessions 5 and 6, across Lot 7, 10 chains of muskeg regraded and covered with clay.

Road between Lots 2 and 3, across Concessions 4, 5, and 6, 2¾ miles graded, 7 culverts built and grades improved on 3 hills.

Road between Concessions 4 and 5, across Lots 11 and 12, 1 mile stumped and grubbed.

Road between townships of Bowman and Hislop, 1 bridge built, 30 ft. span.

Field of grain in Temiskaming.

Township of Carr:

Road between Lots 8 and 9, across Concessions 1 and 2, 1¼ miles graded.

Road on Lot 2, Concession 1, 1 bridge built, 20 ft. span.

Road on Lot 10, Concession 1, 1 culvert built and 20 chains regraded.

Road between Concessions 3 and 4, on Lots 1, 2 and 3, 2 bridges, 20 ft. span and 6 culverts built and 500 cu. yds. clay fill.

Road between Lots 2 and 3, 1 mile gravelled and 500 cu. yds clay fill on Concession 3, 2 miles regraded, 2 miles dragged across Concessions 3 and 4.

Road between Concessions 1 and 2, across Lot 5, ½ mile graded and 3 culverts built.

Road between Lots 4 and 5, 2 miles regraded, ¾ mile stumped and grubbed across Concession 5.

Road between Townships of Carr and Beatty, 2 miles regraded.

Road between Townships of Carr and Bowman, 10 chains gravelled.

Road between Concessions 2 and 3, across Lots 1 and 2, 1 mile dragged.

Road between Concessions 5 and 6, across Lots 5, 6, 8, 9 and part of 7, 2¼ miles stumped and grubbed.

Road between Concessions 4 and 5, 1 mile cut, stumped and grubbed across Lots 5 and 7, ½ mile cut, logged and burned across Lot 6.

Trunk Road on Concession 1, across Lots 7, 8 and 9, 1¼ miles gravelled.

Road between North and South halves Lot 12, Concession 4, ½ mile cut, stumped and grubbed.

Road between Lots 4 and 5, 30 chains stumped and grubbed and 29 chains graded across Concession 4.

Road between Concessions 4 and 5, across Lots 1 and 2, 58 chains graded and 2 culverts built.

Road between Townships Currie and Bond, 40 chains stumped and grubbed across Concession 4, and part of 2 miles burned across Concessions 5 and 6.

Township of Hislop:

Road between Concessions 5 and 6, across Lots 4, 5, 6 and 7, 2 miles regraded.

Road between Lots 9 and 10, 1 mile stumped, grubbed and graded, and 2 culverts built.

Road between Concessions 4 and 5, ½ mile cut, stumped and grubbed and 4 culverts built on Lot 8. One mile graded across Lots 8 and 9.

Road between Lots 7 and 8, across Concession 4, 30 chains cut, stumped and grubbed.

Road between Lots 9 and 10, across Concessions 2 and 3, 1⅛ miles cut and burned.

Road between Concessions 2 and 3, ¾ mile stumped, grubbed and burned across Lots 12 and 13, ½ mile graded across Lot 13.

Township of Playfair:

Road between Lots 2 and 3, across Concession 5, 1 mile cut, logged and burned, ¾ mile stumped and grubbed.

Road across Lot 8, Concession 6, ½ mile cut, stumped and grubbed.

Road between Lots 8 and 9, across Concession 6, 1 mile cut, stumped and grubbed.

Road between Concessions 5 and 6 on Lot 4, 80 cu. yds. filling at approach to bridge.

Township of Stock.

Road between Concessions 1 and 2, 1½ miles cut and burned, across Lots 1, 2 and 3, 1 mile graded and 7 culverts built across Lots 1 and 2.

Township of Taylor:

Road between Concessions 2 and 3, road, culverts and bridges repaired, across Lots 1 to 6 inclusive, ½ mile graded across Lot 7, ½ mile stumped and grubbed across Lot 8.

Road between Lot 8 and 9, across Concession 2, 1 mile stumped and grubbed.

Road between Lots 10 and 11, across Concessions 3 and 4, 2 miles cut and logged.

Road between Townships of Taylor and Carr, ½ mile regraded across Concession 2.

Township of Walker:

Road between Concessions 5 and 6, across Lots 10, 11 and 12, 1½ miles cut and burnt.

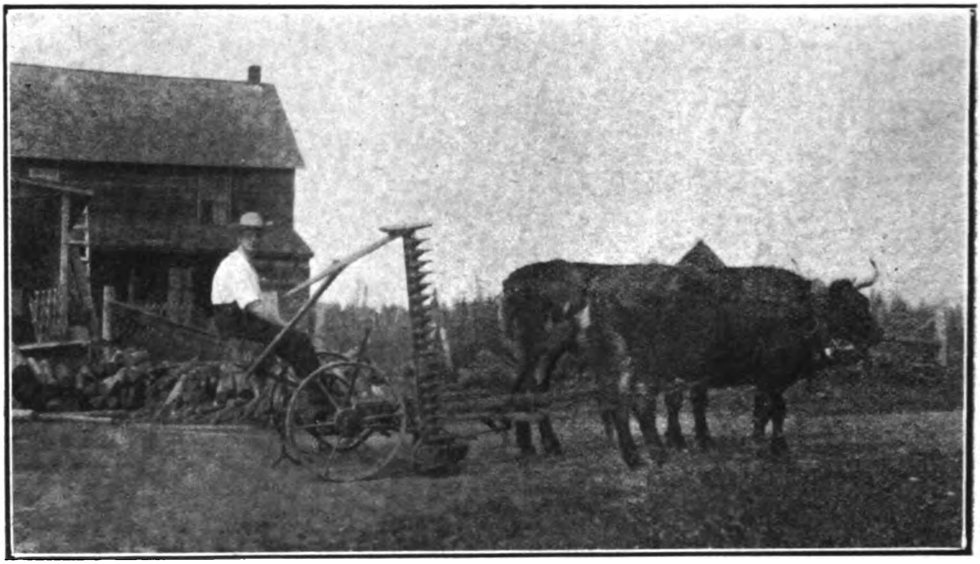
Road between Concessions 3 and 4, across Lot 12, ½ mile cut and burnt.

Road between Concessions 4 and 5, ½ mile stumped and grubbed across Lot 12, 10 chains repaired Lots 10 and 11.

Road between Lots 10 and 11, across Concession 1, 50 chains cut and logged.

Road across Concession 2, 1 mile cut, stumped grubbed and graded .

Road on Lot 12, Concession 2, bridge built across Driftwood River and approaches filled.



A settler's first team in Temiskaming.

Township Boundaries:

Ten chains of crosslaying repaired between Walker and Clergue and roads repaired between the townships of Walker, Clergue, Stock and Bond.

Road to Lightning River, Mineral Belt, 35 miles cut to provide winter road and later repaired to make it passable as summer road, through township of Munro, McCool, Michaud and unsurveyed territory.

Road between townships of Currie and Taylor, old corduroy lifted, muskeg regraded and covered with clay across Lots 1 to 4 and 8 to 11, both inclusive.

Road between townships of Carr and Bowman, old corduroy lifted, muskeg regraded and covered with clay across Lot 12.

PORCUPINE DISTRICT.

Township of Delora:

Road to Ankerite Mine in continuation of road under construction by township of Tisdale, ½ mile graded and ¼ mile surfaced with rock.

Road between townships of Delora and Ogden, known as Hayden Road, 1 mile surfaced with gravel.

Township of Mountjoy:

Road South side of Mattagami River, scow at crossing repaired and location altered, 3 miles graded, 7 culverts built, 1,917 yds. ditched, 63 rods corduroy laid. One bridge built 16ft. by 60 ft. and 300 yds. surfaced with gravel.

Road East side of Mattagami River, 7/8 mile graded, 400 yds. ditched, 2,330 cu. yds. earth fill, 3 culverts built.

Township of Tisdale:

Trunk Road, South Porcupine to Timmins, 4 miles repaired, 2 miles surfaced with rock and gravel.

Road from Golden City to South Porcupine via Pottsville on North side of Porcupine Lake, 1 bridge built 16 ft. by 90ft., approaches and piers filled with rock, 1,000 ft. of corduroy 8 ft. wide surfaced with rock, 200 ft. of corduroy laid, 4 large culverts built, 1 mile graded, 1,400 yds. ditched and 3/4 mile of road repaired.

Township of Whitney:

Road from Golden City to South Porcupine along T. & N. O. Railway, 1 1/4 miles surfaced with rock and gravel and 3 culverts built.

ELK LAKE-GOWGANDA ROAD.

A satisfactory improvement on this road without a large expenditure is very difficult, the traffic is not extensive but the length of the road, some 28 or 30 miles, results in the drawing of exceedingly heavy loads, which, with narrow tires, cut the road down to a boulder bottom making travel upon it rough, uncomfortable and disagreeable.

First class gravel for road building is very scarce along the route of the road, so that no work approaching a permanent nature is possible without the use of crushed rock.

The work done upon the road was carried out under great difficulty owing to the labour shortage and unsuitable weather conditions. Several miles of the road were graded and surfaced with gravel, special attention given to drainage. Many of the old wooden culverts were replaced with steel culverts. The old bridge at Long Point was replaced by a smaller bridge and an extensive fill. At the 22 mile post, the old culvert with corduroy approaches was renewed and approaches filled in. The bridge at Miller Creek was replaced and proper approaches made.

Other work consisted of re-surfacing the worst places on the road and repairing the corduroy.

SWASTIKA-KIRKLAND LAKE ROAD.

General repairs were made along this road, about 3/4 of a mile was graded and 1 3/4 miles surfaced with crushed rock. Twenty-four wooden culverts were replaced with steel culverts and the Lake Shore hill was reduced by the removal of about 350 cu. yds. of rock.

HAILEYBURY-NEW LISKEARD ROAD.

About 3,000 ft. of this road was graded and 7,000 ft. of water-bound Macadam was laid. Four new steel culverts were placed and on other parts of the road slight repairs were made in the way of grading and cleaning side ditches.

LORRAIN ROAD.

This work was done upon that part of the road lying North of the Green Meehan Mine, 2 culverts were replaced, 645 ft. of grading was done and 700 ft. surfaced with rock.

SUMMARY.

The following is a summary of work done during the season.

Old and new roads under construction or repair	273	miles
New roads under construction	110	"
New roads made ready for grading	86	"
Roads graded	71	"
Roads surfaced with rock or gravel	25	"
Bridges built or renewed	28	
Culverts built or renewed	253	

To the Honourable the Minister of Lands, Forests and Mines:—

Sir,—I beg to submit for your consideration and recommend that the following amounts be expended during the season of 1919 on the construction of new roads, the maintenance of lately constructed trunk roads, the re-surfacing with stone or gravel of old roads, the construction of bridges and culverts and the drainage of swamp lands in the Districts of Rainy River, Kenora, Port Arthur and Fort William, Sault Ste. Marie, Algoma, Sudbury, Nipissing, Parry Sound, St. Joseph Island and Muskoka:

District of Rainy River:

In the District of Rainy River there are not less than 125 miles of trunk roads to be maintained and dragged; 25 miles of constructed road requiring surfacing with gravel at different points throughout the District and 25 miles of new road to be constructed to meet the immediate requirements of the settlers; also a small expenditure in the mining section east of Rainy Lake. This work will cost approximately $75,000

District of Kenora:

Repairing and maintaining old roads in the vicinity of Kenora and Keewatin, the construction of trunk roads between Dyment and Eagle River Stations along the Canadian Pacific Railway and along the Canadian Government Railway in the vicinity of Quibell and Superior Junction.. 45,000

District Surrounding Port Arthur and Fort William:

Maintenance of 150 miles of trunk roads, the construction of 30 miles of new roads east of Port Arthur and the surfacing with gravel of 10 miles of old roads, including also the mining road from Schreiber Station, Canadian Pacific Railway to Big Duck Lake now under construction 80,000

Sault Ste. Marie Trunk Road:

The construction of the 17 mile gap on the Sault Ste. Marie and Sudbury trunk road between Algoma Mills and Cutler and maintenance of the trunk road between Sault Ste. Marie and Algoma Mills 100 miles.. 75,000

Sudbury and Algoma Districts:

Re-grading and gravelling in places the Sudbury and Soo trunk road between Copper Cliff and Cutler 30,000

St. Joseph Island:

Completing the trunk road system on St. Joseph Island 15,000

Districts Surrounding the Sudbury Mining District:

Surfacing new road between Coniston and the Garson Mine, constructing and grading a new road between Capreol Station on Canadian Northern Railway and the Selwood Iron Mine on Canadian Northern Railway, maintenance of 50 miles of trunk roads, east, west and north of Sudbury 50,000

Nipissing Districts:

Construction of bridges, repairs and gravelling and new roads from Warren, Canadian Pacific Railway east to Mattawa on Canadian Pacific Railway 40,000

Districts of Parry Sound and Muskoka:

The extension of the North Bay and Toronto trunk road through the Districts of Parry Sound and Muskoka to a point south of Gravenhurst; also trunk road from Trout Creek Station on Grand Trunk Railway west to Loring; also the gravelling in places and maintenance of the North Bay trunk road from North Bay south to Huntsville and other roads in the vicinity 75,000

District of Nipissing:

The extension of the Mattawa and Pembroke trunk road from Mattawa east 50,000

Unforeseen work, repairing roads, bridges 30,000

Office and engineering expenses, equipment and new plant 30,000

$595,000

J. F. WHITSON,

Commissioner.

Toronto, Ontario, January 15th, 1919.

To the Honourable G. H. Ferguson, Minister, Lands, Forests and Mines, Ontario:

SIR,—Under the provisions of the Acts of 1912 and subsequent amendment for the Development of Northern and North-western Ontario, I recommend for the construction, maintenance and repairs of roads and bridges the following expenditures, for the season ending October 31st, 1918.

In the territory served by the Temiskaming and Northern Ontario Railway from Latchford to Cochrane.

(1) From Latchford to Swastika including the Elk Lake and Charlton branches of the railway and the mining camps of Boston Creek, Kirkland Lake and Larder Lake	$75,000
(2) From Swastika to Monteith, this includes the area about Matheson, which is opening up so readily	50,000
(3) From Monteith to Cochrane, including the Iroquois Falls branch and Porcupine branch of the railway as far as the Porcupine River	50,000
(4) The Porcupine Mining District, including Mountjoy Township and the bridge over the Mattagami River	50,000
In the territory served by the Canadian National Railways, from the Quebec boundary to Grant, and southerly along the Algoma Central Railway to Oba.	
(1) From the Quebec boundary west to Fauquier including roads for Soldiers' and Sailors' Colony in Shackleton Township	50,000
(2) From Fauquier to Grant including roads for Soldiers' and Sailors' settlement in O'Brien and Owens Townships	50,000
Unforeseen expenditures	32,500
	$357,500

All of which is respectfully submitted.

I have the honour to be, Sir

Your obedient servant,

C. H. FULLERTON,

Acting Director, Northern Development Branch, Temiskaming District.

REPORT OF ONTARIO GOVERNMENT CREAMERY, NEW LISKEARD, ONTARIO.

To the Honourable, the Minister of Lands, Forests and Mines, Ontario:

SIR,—I beg to submit report of the Creamery from November 1st, 1917, to October 31st, 1918. As we expected a great many of the farmers took advantage of the ready market for their cream, and the steady cash revenue derived from the Creamery.

The past year we had two hundred and twenty-two take advantage of this, and upwards of nine hundred cows were furnishing cream to the Creamery, ranging in herds from two to ten cows. 272,834 lbs. cream were received which produced 67,937.3 lbs. fat, and 84,541 lbs. butter. $33,015.09 was distributed among the farmers at the lower part of the Clay Belt. The average price paid for fat was 48.5 cents per pound, value of butter, $38,768.71, average 46 cents per pound, a price that was never before realized in this part of the Province, taking into consideration the amount of butter made at the Creamery.

If this amount had been made into dairy butter farmers would not have realized more than twenty to twenty-five cents per pound, and no cash for their product.

The Matheson District expect to send cream from 150 cows this coming year, as the good railway facilities for shipping cream from points north of here, is a good advantage to the farmers. Milch cows have come in, in great numbers, and while not the kind we would like to see in every case, some very fine pure bred cows have been brought in.

I am starting a cow testing association in the spring in order to try and eliminate as far as possible, the star boarders that a number of the farmers have in their stables. Farmers are falling in line, and no doubt it will be a great success.

I have the honour to be, Sir,

Your obedient servant,

A. MACLACHLAN,

Manager.

SUMMARY OF EXPENDITURE FOR THE SEVEN YEARS ENDING 31ST OCTOBER, 1918.

Northern and Northwestern Ontario Development Fund.

Description.	Year ending 31st Oct., 1912.	Year ending 31st Oct., 1913.	Year ending 31st Oct., 1914.	Year ending 31st Oct., 1915.	Year ending 31st Oct., 1916.	Year ending 31st Oct., 1917.	Year ending 31st Oct., 1918.	Total Expenditure.
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Sec. 1 (a). Works	....	....	2,100 00	....	....	....	....	2,100 00
Sec. 1 (b). Roads	193,082 80	1,081,172 28	791,443 08	582,914 80	513,533 75	485,493 33	633,821 43	4,281,461 47
Sec. 1 (d). Farms	....	....	9,035 11	8,075 68	10,125 53	18,181 52	9,551 96	54,969 80
Sec. 1 (e), Creamery, New Liskeard	....	....	....	....	....	15,624 86	7,822 39	23,447 25
Sec. 3 Seed Grain	....	....	....	98,920 26	24,916 63	31 50	11,342 47	135,210 86
Returned Soldiers' and Sailors' Settlement Act, 1917, Clause 5	....	....	....	....	....	138,812 05	466,276 09	605,088 14
	193,082 80	1,081,172 28	802,578 19	689,910 74	548,575 91	658,143 26	1,128,814 34	5,102,277 52
Clause 9 (Amending Act 1916) Settlers' Loan Account	....	....	....	....	26,370 98	370,731 99	43,524 83	440,627 80
	193,082 80	1,081,172 28	802,578 19	689,910 74	574,946 89	1,028,875 25	1,172,339 17	5,542,905 32

ARTHUR E. D. BRUCE,
Secretary and Accountant.

November 18th, 1918

STATEMENT OF EXPENDITURE UNDER NORTHERN & NORTHWESTERN ONTARIO DEVELOPMENT ACTS, 1912 AND 1915.

(From 23rd May, 1912, to 31st October, 1918.)

District	Expenditure year ending 31st Oct., 1918.
1. District of Nipissing, Parry Sound and Muskoka. North Bay to Callander; Petawawa to Pembroke; Callander to Utterson on G. T. Ry.; Powassan to Nipissing Village; North Bay to Markstay on Canadian Pacific Railway	$44,061 07
2. District of Temiskaming. Haileybury, Englehart, Matheson, Charlton, Swastika, Elk Lake, Larder Lake	101,188 15
3. District of Temiskaming. Cochrane, Porcupine, Iroquois Falls, and Transcontinental Railway from Quebec boundary west 125 miles to Kapuskasing	165,828 66
4. District of Sudbury. Vicinity of the town of Sudbury and Mining District surrounding, and Sudbury-North Bay Trunk Road	57,468 39
5. District of Algoma. Vicinity of Hearst, along Transcontinental and Algoma Central Railways	22,680 97
6. District of Algoma, on Sudbury and Sault Ste. Marie Trunk Road, Sault. Ste. Marie to Algoma Mills	10,331 67
7. District of Thunder Bay. Tributary to Port Arthur and Fort William	82,724 52
8. District of Kenora. Vicinity of Kenora and Keewatin and between Wabigoon and Dryden and Oxdrift on Canadian Pacific Railway	14,234 31
9. District of Rainy River, in Rainy River Valley	69,480 59
10. Algonquin Provincial Park	13,722 79
11. Manitoulin Island	16,151 51
12. St. Joseph Island	17,960 99
13. Experimental Farm Plots	9,551 96
14. Creamery, New Liskeard	7,822 39
15. Seed Grain	11,342 47
16. General Administration Expenses	17,987 81
	$662,538 25
17. Soldiers' Settlement Account	466,276 09
18. Settlers' Loan Account	43,524 83
	$1,172,339 17

ARTHUR E. D. BRUCE,
Secretary and Accountant.

STATEMENT OF EXPENDITURE, YEAR ENDING 31ST OCTOBER, 1918.

Making of Roads:

Grigg, A., Deputy Minister, salary	$400 00	
Whitson, J. F., Commissioner, salary	4,500 00	
Bruce, A. E. D., Secretary and Accountant, salary	3,000 00	
Beardall, F. G., Clerk (allowance on military leave)	1,335 00	
Dower, A. R., Clerk (allowance on military leave)	935 00	
Reid, A., Clerk (allowance on military leave)	728 92	
Lawer, W. L., Bookkeeper, salary	1,475 00	
Laidlaw, Miss B., Stenographer, salary	867 50	
Extra Clerks	4,746 39	
		17,987 81
Wages	$342,957 34	
Contracts	109,020 97	
Supplies and equipment	163,855 31	
		615,833 62
		$633,821 43

Advancement of Settlement and Colonization:			
Wages	$4,603 46		
Contracts	620 00		
Supplies, stock and equipment	4,328 50		
		9,551 96	
Creamery at New Liskeard:			
Wages	$2,485 06		
Contracts	528 00		
Supplies and equipment	4,809 33		
		7,822 39	
Seed Grain:			
Wages	$195 82		
Seed, freight and expenses	11,146 65		
		11,342 47	
Returned Soldiers' and Sailors' Land Settlement Act—Monteith and Kapuskasing:			
W. G. Nixon, Superintendent, salary	$2,166 67		
Wages	149,405 93		
Contracts	85,797 75		
Construction of settlers' houses and other buildings, railway siding, equipment and supplies	228,905 74		
		466,276 09	
			$1,128,814 34
Settlers' Loan Department:			
Dane, F., Commissioner, salary	$5,000 00		
Kennedy, W. K. P., Accountant, salary	2,500 00		
Crawford, Miss G., Stenographer, salary	732 50		
		$8,232 50	
Net amount of loans issued	$34,817 43		
Expenses	474 90		
		35,292 33	
			43,524 83
			$1,172,339 17

ARTHUR E. D. BRUCE,
Secretary and Accountant.

SPECIAL WARRANT ACCOUNTS.

ADMINISTERED BY THE NORTHERN DEVELOPMENT BRANCH.

EXPENDITURE TO 31ST OCTOBER, 1918.

Order-in-Council dated 30th September, 1916—		
Erection of log house at Ottawa Exhibition	$1,776 50	
Free Seed Grain for seeding down burnt lands	9 63	
Erection of Stock Judging Pavilion, New Liskeard	20,132 09	
		$21,918 22
Part of Order-in-Council, 10th October, 1916—		
Erection of schools at Matheson and Porquis Junction (Balance refunded to Provincial Treasurer)		15 08
Order-in-Council dated 20th February, 1917—		
Cost of rams purchased (19)	$565 00	
Expenses and freight	29 88	
		594 88
Order-in-Council dated 18th May, 1917—		
Purchase of horses and other live stock		
Cost of 40 cattle and expenses in connection therewith		4,780 05

Order-in-Council dated 18th May, 1917—	
Returned Soldiers' Recreation Account—Expenditure, 1918	1,193 73
Order-in-Council dated 11th December, 1917.	
Relief of sufferers in Halifax disaster; purchase of glass, beaver board, tar paper, sheets and pillow cases	20,996 96
	$49,498 92

REVENUE ACCOUNT, 1918.

The Making of Roads:		
Refund on bridges and sale of supplies and stock	$3,357 96	
Advancement of Settlement and Colonization:		
Sale of pulpwood, produce, etc., and rent	2,369 21	
Creamery at New Liskeard:		
Sale of butter, cream, cans, etc.	5,068 88	
Seed Grain:		
Notes retired and cash paid	12,853 86	
Returned Soldiers' and Sailors' Land Settlement Act:		
Sale of provisions, supplies, board and equipment, etc.....	43,499 99	
Special Warrant Accounts:		
Sales and refunds	5,647 68	
	$72,797 58	
Settlers' Loan Account:		
Payments on principal, interest and refunds	45,184 63	
Total Revenue under all heads, 1918 Account		$117,982 21

NORTHERN DEVELOPMENT BRANCH.

SEED GRAIN.

Amount refunded by Settlers for Seed Grain Supplied.

Oct. 31st 1915, by notes retired and cash paid	$3,171 36
Oct. 31st, 1916, by notes retired and cash paid	29,320 00
Oct. 31st, 1917, by notes retired and cash paid	18,119 04
Oct. 31st, 1918, by notes retired and cash paid	12,853 86
Total refunded, 4 years ending 31st October, 1918	$63,464 26

RECORD OF CORRESPONDENCE.

For year ended 31st October, 1918.

Letters received		8,203
Letters mailed	6,202	
Circulars mailed	1,348	
		7,550

ARTHUR E. D. BRUCE,
Secretary and Accountant.

Appendix No. 31.

REPORT OF THE FORESTRY BRANCH, 1918.

SIR,—The report of the work of the Forestry Branch for the year ending 31st October, 1918, falls into the three sections of Forest Protection, Reforestation, and Tree Diseases.

I. FOREST PROTECTION.

(1) *Legislation.*

The only change in The Forest Fires Prevention Act, under which forest protection is carried on, is an amendment passed at the last session of the Legislative

1—Type of light truck used by the Forestry Branch in fire protection service.

Assembly which provides for arrangements with an owner for additional protection. In such cases the Minister appoints extra rangers who are paid by the owner of the land, the remuneration to be approved by the Minister. Under this amendment four extra rangers were appointed this season.

(2) *Organization and Personnel.*

Some re-arrangement of district boundaries was made involving consolidation in five cases and sub-division in two others, resulting in a reduction of the Chief Ranger Districts to 32. An additional Inspector was appointed, making four inspectorates of the Province, with headquarters at Cochrane, Nipigon, Sudbury and Parry Sound. The number of Deputy Chief Rangers, whose duties are entirely supervisory, was increased to 41 this season. With 32 Chiefs this pro-

vided for direct field supervision on the basis of one to every 15 rangers. The Inspectors, working under the Superintendent, form the connecting link between the field and head office.

The spring opened early and being continuously dry the fire season opened much earlier than in 1917. April pay lists totalled 212 names and May, 1,002 names, as compared with 84 and 828 respectively in 1917. Moreover, the May pay list was for the full month in most cases. In addition it was found necessary to raise the general scale of rangers' wages throughout by 25 cents per day, thus increasing the season's pay roll expenditure by 10 per cent. This was partly offset by the wet weather in September allowing of a curtailment. The number of names appearing on the monthly pay lists was: April, 212; May, 1,002; June, 1,094; July, 1,117; August, 1,047; September, 929; October, 27. Of this number, 538 rangers were on the force of 1917. The pay roll for the whole field force for the season amounted to around $416,500. The other main items of expenditure were, in round figures: equipment, $28,350; expendable property, $10.700; travelling expenses on inspection work, $13,440; improvement work, $4,280; extra assistance for fire fighting, $1,445; express, freight, cartage, telephone and telegraph tolls, etc., $5,365.

In connection with the protection of forest land under license, the Department receives from the licensees recommendations for fire rangers. On this basis, some 218 rangers were appointed for 1918 on the recommendation of 90 licensees for 10,050 square miles, an average of 46 square miles (29,440 acres) per ranger. The licensed area protected totalled approximately 16,900 square miles, representing some 255 licensees.

(3) *Records.*

This season Chief Rangers were required to submit a report weekly covering all phases of the work in their district. Rangers keep a daily diary, using a prescribed blank form, and these diaries are forwarded to Head Office monthly. Operators of railway motor cars, automobiles and boats, send in a weekly report showing movements and mileages each day with consumption of gasoline and oil. A system of property accounting has been instituted in connection with the recommendation of accounts for payment in Head Office. A card system has been inaugurated for recording cost of protection in each chief ranger district, together with a classification of the expenditures.

(4) *Fires.*

The weather during the fire season of 1918 was abnormal in several respects. March was a comparatively mild month, as also was April with a mean temperature 2.5 degrees above normal. In addition April was unusually dry throughout. May provided some exceptionally hot weather, so that on the whole the mean monthly temperature was 5 degrees above normal. On top of this the rainfall was below the average. As a result the patrol force had to be sent out about two weeks earlier than usual, and practically brought up to the maximum number the first week in May. Thus there were 212 and 1,002 rangers in April and May respectively on duty as compared with 84 and 828 in 1917. The summer months were conducive to a low fire risk with the exception of two very hot dry weeks in August. With the exception of the western end of Ontario, September rains were frequent and heavy, and it was possible to call off the patrol by the 15th in many districts and around the 20th in the southern ones. The season as a whole was distinctly favourable for fire control.

Classification of Forest Fires, 1918

By Month	1918	1917	By Origin	1918		1917	By Size	1918		1917
	No.	No.		No.	%	%		No.	%	%
April......	79	449 (April and May)	Settlers	78	8.1	8.2	¼ ac. and under....	391	40.5	36.3
May.......	215		Campers	79	8.2	8.9	Over ¼ to 5 ac......	325	33.7	19.5
June.......	273	320	Railways	449	46.5	49.5	Over 5 to 10 ac.....	58	6.0	4.8
July.......	124	158	Lightning	37	3.8	2.9	Over 10 to 100 ac...	131	13.6	9.5
August....	268	117	Indians.......	14	1.5	5.C	Over 100 to 500 ac..	49	5.1	4.7
September.	6	66	Logging oper. .	40	4.1	4.1	Over 500 ac........	11	1.1	25.2
			Miscellaneous	44	4.6	3.6				
			Unknown.....	224	23.2	17.8				
	965	1110		965	100.0	100.0		965	100.0	100.0

Railway Fires.—As in 1917, nearly one-half (46.5 per cent.) of the total number of fires for the season was of railway origin, that is to say, to defective locomotives or carelessness on the part of railway employees. The unsatisfactory condition of fire protective appliances on locomotives is evident from the statement regarding locomotive inspection farther on in this report. Along with this it must be remembered that right-of-way conditions are at least equally as important as the maintenance standard of locomotives from the standpoint of forest fire hazard.

It must be clearly kept in mind that by "railway fires" are meant specifically those of railway origin. The term does not by any means include all those fires occurring along railway lines. Thus, this season, 538 fires were reported as starting on the right-of-way or immediately adjacent thereto. As to cause, these were classified thus: due to railways, 449; other known causes, 19; of unknown origin, 70; that is to say 89 fires or 16.5 per cent. of those along railway lines were not charged to railway operation.

STRICTLY RAILWAY FIRES, 1918

Railway	Mileage through Forest Section	No. Fires	Per cent of total fires
C.N.R.	1,455	114	25.4
C.P.R.	1,430	112	24.9
C.G.R	950	98	21.8
G.T.R..................................	375	60	13.4
T. & N.O	312	47	10.5
A.C..................................	330	5	1.1
A.E..................................	85	13	2.9
	4,940	449	100.0

In the case of all the above lines the majority of the fires were reported from a comparatively small percentage of the total mileage concerned. Thus of the 114 Canadian Northern fires, 29, 24, 14 and 10 fires occurred on the Ruel, Muskoka, North Bay and Maynooth subdivisions respectively; that is to say, two-thirds of the fires happened on 4 out of the 13 subdivisions. Likewise in the case of

Canadian Pacific Railway, the Nemegos subdivision with 35 fires, Mactier with 28, North Bay with 14, and Parry Sound with 10 fires, accounted for over three-quarters of the 112 Canadian Pacific fires.

Other Causes.—After the railways the careless camper was the cause of the next largest number of fires, namely, 9.7 per cent. of the total (including Indians), as against 14 per cent. last season.

Land clearing operations by settlers caused 78 fires or 8.1 per cent. of the total. Of these, 50 fires were outside, and 28 fires inside, the permit area. Of the latter, 17 were cases of fires set out under permit getting beyond control, and 11 were cases of violations of the Permit Regulations, half of them instances of misunderstanding. Prosecutions were conducted in 5 cases and convictions secured in all.

2—Forest planting on sand lands at the Provincial Forest Station, Norfolk County, 1909.

Forty fires were connected with logging operations. These included carelessness of river drivers, cleaning up around camps, and defective logging locomotives.

Area Burned.—Forty per cent. of all fires did not exceed one-quarter acre in size, and nearly three-quarters of them did not get beyond 5 acres in extent.

The total area burned over was 30,172 acres, classified thus:

Timbered land, 4.757 acres (15.8 per cent.); cut-over land with some timber left, 11,174 acres (37.0 per cent.); young growth, 7,100 acres (23.5 per cent.); barren and grass land, 7,141 acres (23.7 per cent.) It must again be pointed out that cut-over land and young growth, as representing the forest land that has been logged over with the resultant hazardous slash, constituted 60 per cent. of the total burned over area.

STATEMENT OF FOREST FIRES, 1918

District	Number of fires	Timber land mainly coniferous (i.e. softwo'd)	Timber land mainly hardwood	Cut-over land, some softwood left	Cut-over land, some hardwood left	Young growth mainly coniferous	Young growth mainly hardwood	Barren land	Grass land	Totals (acres)
I. Western Inspectorate—										
1 Kenora District	21	403	...	985	...	7	...	1	...	1,396
2 Rainy River	47	327	100	575	1,920	10	7	555	27	3,521
3 Thunder Bay	65	98	...	321	486	188	100	406	61	1,660
4 Nipigon	11	1	...	...	...	...	611	...	7	619
5 C.G.R.—Western	77	...	...	2	...	20	...	89	8	119
6 C.G.R.—Central	18	...	...	...	...	2	...	...	2	4
II. Northern Inspectorate										
1 Hearst	13	...	...	1	...	...	...	...	2	3
2 Cochrane	35	...	...	87	...	...	110	11	11	219
3 Abitibi	7	...	...	11	4	...	...	6	...	21
4 Timmins	18	370	...	113	18	301	...	76	...	878
5 Matheson	24	...	...	36	...	10	43	9	...	98
6 New Liskeard	16	15	...	555	...	10	100	430	...	1,110
III. Central Inspectorate—										
1 Soo	13	320	...	...	850	20	5	1,283	30	2,508
2 Webbwood	23	...	78	...	35	10	45	436	57	661
3 Sudbury	42	...	...	29	...	48	441	8	7	533
4 Sturgeon Falls	8	...	...	...	320	...	...	2	...	322
5 North Bay	34	27	14	1	1	...	154	733	5	935
6 Mississagi	11	31	...	...	2	1	...	...	...	34
7 Chapleau	59	53	26	746	...	166	8	68	14	1,081
8 Foleyet	46	453	...	1,517	...	234	...	5	4	2,213
9 Timagami, West	1	...	...	2	...	...	...	...	...	2
10 Timagami, South	17	150	...	40	400	2	...	6	2	600
11 Timagami, East	10	1	...	...	...	7	...	...	...	8
12 Timagami, North	6	2	...	...	...	4	...	3	...	9
13 T. & N.O., South	27	...	...	...	...	...	...	...	5	5
IV. Southern Inspectorate—										
1 Parry Sound	33	13	...	513	47	...	172	127	317	1,189
2 Muskoka	91	90	38	55	750	114	586	1,394	51	3,078
3 Algonquin, North	46	160	800	9	150	225	1,532	374	10	3,260
4 Algonquin, South	79	503	575	63	5	25	608	209	27	2,015

5 Madawaska	8	......	......	......	......	175	3	10	3	191
6 Trent	54	106	3	......	525	218	737	223	26	1,838
7 Eastern Reserve	5	......	......	......	......	......	41	1	......	42
Totals	965	3,123	1,634	5,661	5,513	1,797	5,303	6,465	676	30,172
1917 Totals	1,110	73,160	135	148,408	2,160	61,806	13,202	82,959	2,334	384,164

3—Plantation on sand lands of Jack Pine and Scotch Pine, one year after planting.

4—Same plantation as shown in Fig. 3, after three seasons' growth.

(5) *Permits.*

The issuance of permits to settlers to set out fire for clearing land is practically confined to the townships based on the T. & N. O. railway between Cobalt and Cochrane and the C. G. R. from Cochrane to Hearst. In all there were issued 9,590 permits covering 39,683 acres, an average of slightly more than 4 acres per permit, as compared with 3,486 permits for 15,186 acres in 1917. The administration of the permit regulations called for a large number of special rangers, as permits were issued in 136 townships. The following classification shows still further the scattered nature of the permit work:

Twps. in which there were issued.	No. Twps.
Not over 25 permits	71
26 to 50 permits	13
51 to 100 permits	21
101 to 200 permits	20
201 to 300 permits	7
Over 300 permits	4

The majority of the permits, however, were issued in 5 Chief Ranger Districts, as follows:

District	No. of Permits	Area Burned over
Cochrane	3,493	10,267 acres
Matheson	2,346	7,371 "
New Liskeard	2,179	17,868 "
Timmins	651	1,971 "
Hearst	514	1,134 "

The remaining 19 Districts in which permits were issued accounted for but a little more than 4 per cent. of the total number of permits and slightly less than 3 per cent. of the area.

The permit work was heaviest in the following townships:

C'Brien	782 permits	Pacaud	205 permits
Olute	726 "	Kendall	188 "
Glackmeyer	507 "	Armstrong	185 "
Hislop	301 "	Bowman	178 "
Calder	263 "	Carr	175 "
Lamarche	255 "	Dymond	166 "
Fauquier	246 "	Hilliard	161 "
Harley	245 "	Newmarket	159 "
Mountjoy	220 "	Playfair	157 "
Kearns	218 "	Shackleton	149 "

Summary of Permits, 1918

Month	Number	Area
April	29	69
May	2,219	10,940
June	2,899	12,012
July	2,050	7,724
August	2,156	8,339
September	237	599
	9,590	39,683 acres

The administration of the Regulations in the Permit Area has been quite satisfactory this season. But 28 fires were reported as originating from settlers' clearing operations within the Permit Area. Of these, 17 were due to fires set out under permit and escaping from control, burning over 420 acres. The other 11 fires were cases of transgression of the Permit Regulations, some of them where permits had lapsed, the settler not clearly understanding the provisions. Five prosecutions were made and conviction registered in all.

(6) *Improvement Work.*

The new projects carried out this season were:

New trails constructed	304 miles
Rangers' cabins, 12 ft. by 16 ft.	58
Boat houses	2
Lookout towers	12
Railway motor car house	1
Auto garage	1
Nipigon storehouse, boathouse and office.	

The improvement work was carried out largely with ranger labour, the total cost being $4,280.

(7) *Equipment.*

The major items of equipment added this year were as follows: Five Ford auto trucks; five portable fire pumps; six large boats; three railway motor cars; thirty-six railway velocipedes; one hundred tents; sixty-five canoes; blankets, 1,835 pounds.

The usual fire signs were sent out, together with 10,000 copies of a new sign. Two thousand large calendars were distributed for educational effect. A booklet of General Instructions for all field officers was prepared and sent out.

(8) *Railway Inspection Under B.R.C.*

A change was made this year in the handling of the work of the Board of Railway Commissioners for Canada. The special position of B.R.C. Inspector was abolished, and the Board work added to the duties of the Chief Rangers, with the exception of inspection of fire protective appliances on locomotives. This part of the work was looked after by two inspectors who devoted their whole attention to it, because, as already pointed out, approximately half of Ontario's forest fires for the past two seasons, have been of railway origin. The locomotive inspection facts are tabulated below.

Locomotive Inspections, 1918

Railway	Number Inspected					Total Number Locomotives	Total Number Inspections	Inspections Showing Defects	Percentage Defective	Cost per Inspection
	Times									
	1	2	3	4	5					
C.P.R.	119	73	40	12	3	247	448 (328)*	163 (64)	36.4 (19.5)	
C.N.R.	80	26	14	12	2	134	232 (154)	52 (61)	22.4 (39.6)	
G.T.R.	75	30	12	2	1	120	184 (60)	52 (12)	28.3 (20.0)	
A.C.	14	3	4	1	..	22	36 (37)	14 (17)	38.8 (45.9)	
A.E.	1	5	..	1	1	8	20 (36)	14 (20)	70.0 (55.5)	
						531	920 (615)	295 (174)	32.1 (28.3)	$2.59

*Number in brackets are corresponding figures for 1917.

In all, 920 inspections were made of 531 locomotives at 37 different points, and of these, 295 inspections or almost one out of every three showed conditions below the standard requirements of the Board as regards fire protective appliances. Some of these were minor defects to be sure, but the showing on the whole is decidedly unsatisfactory. The average percentage of defective locomotives is higher than last season, and higher in the case of nearly all the railway systems. Percentically, the Canadian Northern shows a great improvement over last year. But the percentage defective does not present the whole situation as regards starting forest fires, for while the C.N.R. engines showed an improvement in conditions and the C.P.R. made a poorer showing (as compared with the previous season) yet the two lines this year showed respectively 114 and 112 fires of railway origin on practically equal mileages through forest section. The explanation lies mainly in the right-of-way conditions which are admittedly bad along the C.N.R. With the cessation of war and freer labour conditions we can expect an improvement in this phase of the work next year.

As in past seasons, the Chief Fire Inspector of the B.R.C. laid down certain requirements as regards patrol by the railway companies along their lines. In so far as special patrolmen for forest fire protection purposes are concerned, the requirements relate mainly to the C.N.R. Twenty-six special patrolmen were called for between Pembroke and Nipigon by the Board's order, but this requirement was not lived up to by the company in anything like a thorough manner. The same unsatisfactory state of affairs has obtained in the past, and it would appear that the only solution will be for the Forestry Branch to put on the patrol.

The co-operative arrangement on the part of the Temiskaming and Northern Ontario Railway Commission in 1917, whereby their locomotives were regularly inspected by us, was continued this season. One hundred and twenty-six inspections of 39 locomotives were made, of which 42 or exactly one-third showed defects.

Ten locomotives used in logging, etc., were required to be brought up to the equivalent of B.R.C. specifications.

The annual statistical report made to the Chief Fire Inspector of the B.R.C. follows:

Statistical Report of Fires Originating Within 300 Feet of Railway Lines in Ontario for Those Lines Subject to the Jurisdiction of the Board of Railway Commissioners for Canada. Season, 1918.

	G. T. R.	C. P. R.	C. N. R.	A. E.	A. C.	Totals	1917 Totals
(a) Railway Fires:							
1. Number, by causes:							
(a) Locomotives, Class A fires	16	18	63	3	4	104	17
Class B fires	41	86	40	1	5	173	119
(b) Employees, Class A fires	....	....	2	1	3	6	3
Class B fires	3	8	9	....	1	21	14
(c) Total of Class A fires....	16	18	65	4	7	110	20
Total of Class B fires....	44	94	49	1	6	194	133
Total of Railway fires....	60	112	114	5	13	304	153
2. Areas burned:							
(a) Young forest growth, acres	203½	264½	293	....	2	763	338
(b) Timber land	29	256	466	....	3	754	110¼
(c) Slashing or old burn.....	637⅜	2,253½	1,985	....	44¾	4,920⅝	5,069⅞
(d) Other classes of land	77¾	307⅞	38	40	....	463⅜	733⅜
(e) Total	947⅝	3,081⅞	2,782	40	49¾	6,901	6,251½
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth.....	20 00	497 50	1,051 00	....	1 00	1,569 50	121 00
(b) Standing timber.........	249 00	771 75	3,588 50	....	70 00	4,679 25	263 00
(c) Forest products	693 75	....	39 00	....	....	732 75	....
(d) Other property..........	1,774 30	296 15	1,166 00	131 50	75 00	3,442 95	874 75
(e) Total	2,737 05	1,565 40	5,844 50	131 50	146 00	10,424 45	1,258 75
(b) Known Causes other than Railway Systems.							
1. Number due to:							
(a) Campers and Travellers Class A fires....	....	1	2	....	....	3	....
Class B fires....	....	....	1	....	....	1	....
(b) Settlers, Class A fires....	....	....	....	....	....	....	1
Class B fires....	....	....	1	....	....	1	2
(c) Other known causes, Class A fires....	....	....	5	....	....	5	....
Class B fires....	....	....	2	....	1	3	4
(d) Total of Class A fires....	....	1	7	....	....	8	1
Total of Class B fires....	....	....	4	....	1	5	6
Total of other known causes..............	....	1	11	....	1	13	7
2. Areas burned:							
(a) Young forest growth.....	....	....	25	....	....	25	....
(b) Timber land.............	....	....	2	....	....	2	....
(c) Slashing or old burn	....	....	60	....	....	60	505½
(d) Other classes of land	....	....	1	....	½	1½	¼
(e) Total	....	....	88	....	½	88½	505¾
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth.....	....	....	40 00	....	....	40 00	....
(b) Standing timber.........	....	....	30 00	....	....	30 00	....
(c) Forest products	....	....	7,000 00	....	....	7,000 00	240 00
(d) Other property..........	....	....	10,174 00	....	....	10,174 00	....
(e) Total	....	....	17,244 00	....	....	17,244 00	....

STATISTICAL REPORT OF FIRES ORIGINATING WITHIN 300 FEET OF RAILWAY LINES IN ONTARIO, ETC.—Continued.

	G. T. R.	C. P. R.	C. N. R.	A. E.	A. C.	Totals	1917 Totals
(c) Fires of Unknown Origin:							
1. Number:—							
(a) Total of Class A fires....	1	6	3	1	....	11	12
(b) Total of Class B fires....	2	18	11	....	3	34	52
(c) Total of all unknown fires	3	24	14	1	3	45	64
2. Areas burned:—							
(a) Young forest growth.....	1	80	5	....	....	86	31
(b) Timber land	....	6	....	....	....	6	14
(c) Slashing or old burn.....	5	739¼	163	....	2	909¼	6,844¾
(d) Other classes of land	....	40¼	6½	3	1½	51¼	176¾
(e) Total	6	865½	174½	3	3½	1,052½	7,066½
3. Value of property destroyed.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth	5 00	....	....	....	....	5 00	7 00
(b) Standing timber	....	....	....	....	....	....	108 00
(c) Forest products	....	....	....	....	....	....	2,482 70
(d) Other property..........	....	30 00	280 00	....	....	310 00	555 00
(e) Total	5 00	30 00	280 00	....	....	315 00	3,152 70
(d) Grand Totals for all Causes:							
1. Number:—							
(a) Total of all Class A fires.	17	25	75	5	7	129	33
(b) Total of all Class B fires.	46	112	64	1	10	233	191
(c) Total of all fires reported	63	137	139	6	17	362	224
2. Areas burned:—							
(a) Young forest growth.....	204½	344½	323	....	2	874	369
(b) Timber land	29	262	473	....	3	767	124½
(c) Slashing or old burn.....	642⅛	2,992¾	2,208	....	44¾	5,887⅝	12,420⅛
(d) Other classes of land	77¾	348⅛	45½	43	1½	515⅞	910⅜
(e) Total	953⅜	3,947⅝	3,049½	43	51¼	8,044½	13,823¾
3. Value of property destroyed:	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
(a) Young forest growth.....	25 00	497 50	1,091 00	....	1 00	1,614 50	128 00
(b) Standing timber.........	249 00	771 75	3,618 50	....	70 00	4,709 25	371 00
(c) Forest products	693 75	....	7,039 00	....	....	7,732 75	2,722 70
(d) Other property..........	1,774 30	326 15	11,620 00	131 50	75 00	13,926 95	1,429 75
(e) Total	2,742 05	1,595 40	23,368 50	131 50	146 00	27,983 45	4,651 45

II. Reforestation.

The work of this Branch in connection with reforestation during the past season has been chiefly concerned with the Provincial Forest Station in Norfolk County.

This Station was established with the following objects in view. To develop a Provincial nursery where forest nursery stock could be grown for distribution to prospective planters throughout Ontario. Also to demonstrate the feasibility of reclaiming worthless lands by reforestation, and to experiment with the various species of forest trees in relation to this work.

5—View of eight-year-old Jack Pine planting. This is the 1909 planting as shown in Fig. 2.

The following is a list of the stock grown in the nurseries at the Station in Norfolk County:

Scotch Pine (*Pinus sylvestris*), seedlings	300,000
Scotch Pine (*Pinus sylvestris*), transplants	97,000
Larch (*Larix europaea*), seedlings	80,000
Jack Pine (*Pinus divaricata*), seedlings	51,200
White Cedar (*Thuya occidentalis*), transplants	41,000
White Spruce (*Picea canadensis*), transplants	28,300
White Pine (*Pinus strobus*), transplants	20,000
Red Pine (*Pinus resinosa*), transplants	5,200
Austrian Pine (*Pinus austriaca*), transplants	4,500
Miscellaneous conifers	2,500
White Elm (*Ulmus americana*)	14,300
Sugar Maple (*Acer saccharum*)	11,600
Black Walnut (*Juglans nigra*)	5,150
Butternut (*Juglans cinerea*)	5,000
Manitoba Maple (*Acer negundo*)	2,700
White Ash (*Fraxinus americana*)	2,700
Tulip (*Liriodendron tulipifera*)	2,500
Hackberry (*Celtis occidentalis*)	2,500
Chestnut (*Castanea dentata*)	1,900
Miscellaneous hardwoods	3,700
Total	681,750

During the past season fifty acres of scrub oak lands were underplanted with white pine. The older plantations are thriving and some very interesting comparisons in the rate of growth of the various species can be shown.

Very little demand has been made by the public for planting material during the past season. This lack of demand is probably caused by abnormal labour conditions. During this season we shipped 100,000 plants to other parts of the Province for experimental planting.

A preliminary survey of the sand dunes in Prince Edward County was made with a view to reforestation. This sand formation presents a different problem from that in Norfolk. The formation is made up of sand ridges with very little vegetation left. These ridges are shifting, forming dunes which will be more difficult to control than the blowing sand on level areas.

III. Tree Diseases.

The work on White Pine Blister Rust has been followed up this season along lines indicated in previous reports.

As indicated last season the stage of the disease found on Ribes (currants and gooseberries) is found throughout the older portion of the Province. Its distribution is so widespread that no methods of general eradication seem possible. Scouting done in the Rainy River, Sudbury and Temiskaming Districts failed to show that the disease had spread into these regions. It was found at points in Renfrew County and it is evident that it will gradually work northward unless some means of eradication are developed.

It has been found that white pine is practically safe if the Ribes are eradicated within a few hundred yards of the pine. Following upon this theory we have started the work of eradicating all Ribes from the Provincial Forest Station in Norfolk where white pine is one of the important species. This seems feasible where isolated blocks of white pine exist as in woodlots of Southern Ontario.

This season's results in eradicating Ribes on the Norfolk area will impress upon the layman the difficulty of carrying out this policy in our wild lands to the north.

One field crew of four men working over a period of four months eradicated 28,195 plants on an area of about 100 acres, while this area was abnormal and contained more Ribes than usual it indicates the impossibility of carrying on such work over large areas of wild land.

For a number of years enquiries have been coming into the Department regarding the diseased condition of white pine throughout the pine areas of Northern Ontario. White pine has been our most important timber tree but it seems to have many enemies. Following your advice the Forestry Branch is making a special study of this problem. The whole policy of handling white pine forests may be influenced by such a study.

Following instructions from this Department, Dr. J. H. Faull, of the University of Toronto, a specialist in plant pathology has undertaken a special study of these problems and you will find his preliminary report appended:

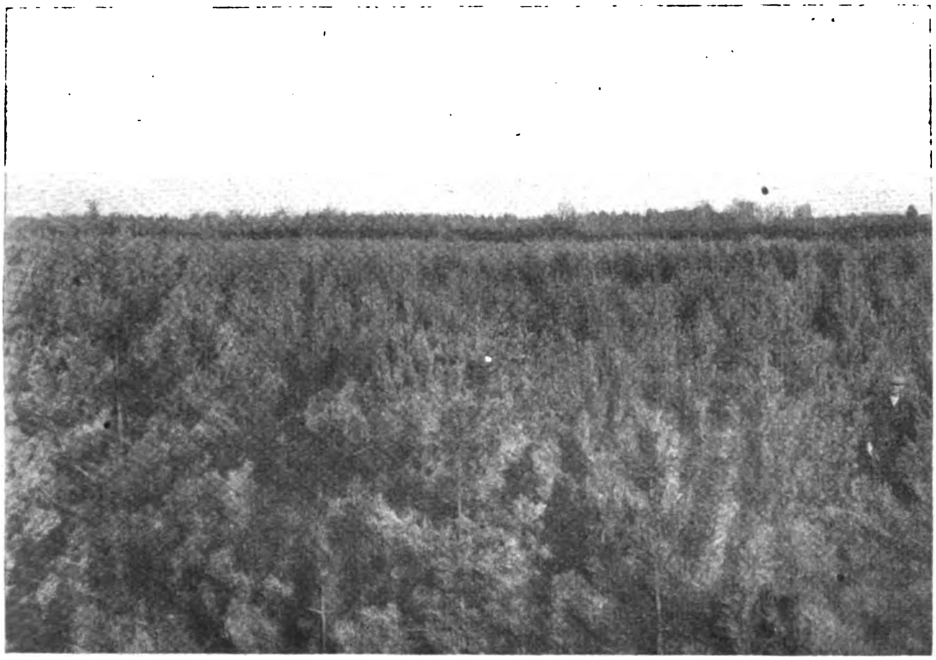
6—Mixed plantation of Scotch Pine and Larch made in 1912 at the Provincial Forest Station.

Preliminary Report of Dr. J. H. Faull:

"The science of forest pathology deals with the health of the forest and that of its products; therefore, the forest pathologist is concerned with the welfare of the standing timber and of the nursery, with the preservation from decay of converted timber, with the prevention of discoloration in lumber and in pulp, and with the exclusion of destructive foreign diseases. Some of the problems in this field have been solved and the results made applicable with monetary advantage—thus it has been discovered that decay is caused by fungi, and that ties, posts and structural timber can be profitably treated so as to guard against the invasion of these wood-destroying agents, further that discoloration in lumber and in pulp is due to certain molds which can be warded off at slight expense, and

that quarantine legislation combined with intelligent inspection can be made effective against the intrusion of foreign diseases. But many problems remain unsolved, notably those of the forest with its multiplicity of unstudied diseases and difficulty controlled situations; and it is just here that destruction—perhaps greater than in the case of fire—goes on unceasingly, especially in over-mature stands, or improperly harvested limits, taking a toll of millions every year.

Considerable advance in this direction has been made in Europe with its regulated forests and long-trained experts, but in America where conditions are very different forest pathologists have only in recent years undertaken investigations on the diseases of our vast virgin forests. Naturally such investigations constitute a *sine qua non* first step towards the solution of our own peculiar problems, for we must become acquainted with the diseases of our forests, their



7—Fifty-acre block of Scotch Pine planted in 1911 at Provincial Forest Station. Trees now six to eight feet high.

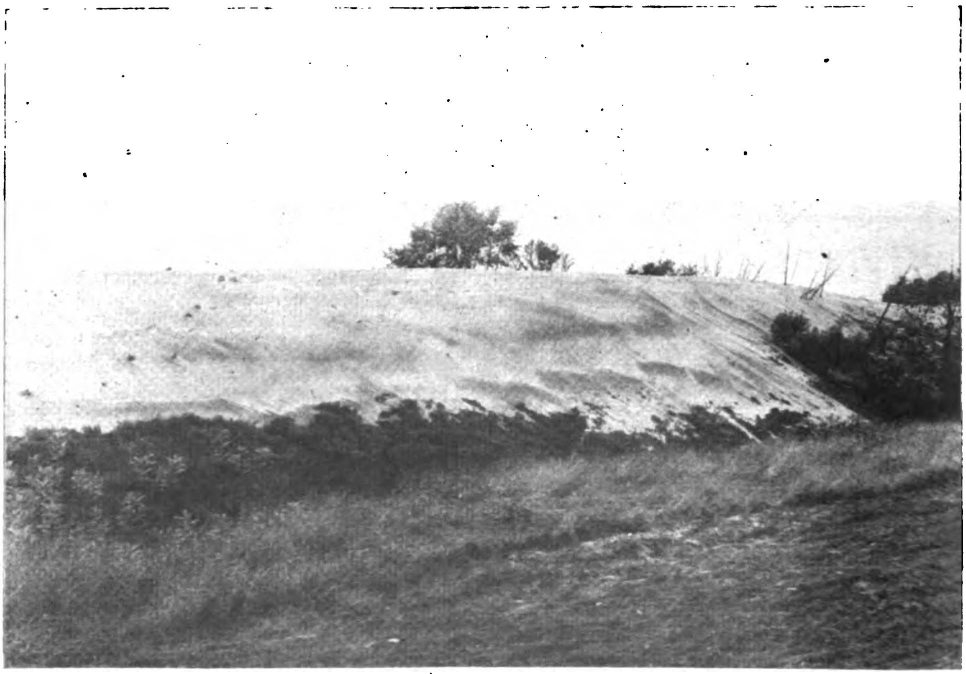
nature, distribution, and relative importance before any important contribution can be made to that essential body of information on which Government and lumbermen base progressive action with reference to conservation or control of the forest.

Work of 1918.

The work of the past summer (1918) was centred mainly on a malady of the white pine known as "needle blight," but in addition two cases of pulp blackening were examined and its cause and prevention indicated, two cases of alleged injury to white pine and other species from fumes were reviewed, and a general survey of the timber diseases of the Timagami Forest Reserve (including an extensive collection) was undertaken.

In response to many complaints from Northern Ontario that the white pine was suffering from a yellowing of the foliage I was directed by the Forestry

8—Sand lands in Prince Edward County which were once covered with timber.



9—Sand dune encroaching on plowed field.

Branch to visit the Timagami Forest Reserve where the affection appeared to be particularly severe, and to make an investigation of its cause and its seriousness. Reference to Washington, D.C., elicited the information that while this disease had been reported from the North-eastern United States it was imperfectly known and its cause not yet ascertained. The prevailing impression in Northern Ontario seemed to be that this discoloration originated in late winter or early spring as an effect of frost, but observation proved that it developed in the new leaves in the latter half of July as they emerged from the buds or were as yet in an early stage of their growth, and experiments demonstrated that the symptoms progress slowly from the needle tips downward and may involve from a third to two-thirds or even the whole needle. Many of the blighted needles fall in August and September, but others adhere for a year or longer. One immediate applica-

10—Sand dune covering apple orchard.

tion of this information—already utilized—consists in the fact that it is now possible to recognize this malady as something distinguishable from sulphur fume injury with which it has been confused; and there is a call for such a diangosis over an area of perhaps 20 miles in radius from roast bed centres.

"Needle blight" is extremely prevalent in the Timagami Forest Reserve. From elevations in the reserve thousands of yellowed trees may be seen, imparting to the normally sombre green coniferous forest the distinctly autumnal tint of a hardwood forest, an effect that is perhaps most pronounced in mid-August. I cannot state how widely spread it may be in Ontario, but I have detected some few cases in Cleland Township, near Sudbury, and some at various points as far south as Gravenhurst and Alliston, also four cases in Rondeau Park on Lake Erie. Trees of all ages are susceptible.

It now remains to be determined whether or not this disease is contagious, the extent of its prevalence, the rate of mortality caused by it, the time required for recovery from the malady, and its effects in such cases on the annual increment of wood. With these ends in view some inoculations were made, some hundreds of diseased trees were noted and marked with numbered metal disks, and a full census of all the white pines taken on a small selected plot.

As a result of the summer's work the following lines of inquiry are in project:

1. A completion of the investigation on the "needle blight" of the pine.

2. A study of the effects of sulphur fumes on pine and especially with reference to the winter roasting of ores.

3. An examination of a brown heart rot of pine, balsam, and spruce which is probably the most destructive agent operating in our northern forests. The special features to be examined refer to the rapidity of development of the decay, the manner and extent of its inroads, and the factors that are responsible for its greater prevalence in some districts than in others.

4. A more complete inventory of the diseases of the pines and the pulpwoods of Ontario."

You will notice that Dr. Faull has found no evidence of White Pine Blister Rust in the Timagami Forest Reserve. His work on "needle blight" and "brown heart rot" should be followed up until we can arrive at some definite conclusions.

I have the honour to be, Sir,

Your obedient servant,

E. J. Zavitz,
Provincial Forester.

Appendix No. 32.

Returned Soldiers and Sailors—Land Settlement.

The Honourable, the Minister of Lands, Forests and Mines, Toronto.

Sir,—I have the honour to report as follows, with regard to the Provincial Scheme of Land Settlement for Returned Soldiers and Sailors.

The Land Settlement Scheme for returned soldiers and sailors was inaugurated in February, 1917, the aim of the scheme being to place returned men in considerable numbers on lands of the Crown in Northern Ontario.

For the present, six townships have been set aside for use in this connection, namely: O'Brien, Owens, Williamson, Idington, Cumming and Shackleton, located some sixty or seventy miles west of Cochrane on the line of the National Transcontinental Railway. These townships with the exception of Shackleton have been surveyed into lots containing 100 acres each instead of the ordinary homestead of 160 acres.

A Training School has been completed at Monteith thirty miles south of Cochrane, on the Temiskaming and Northern Ontario Railway, the school being located on the Government Demonstration Farm consisting of 800 acres. There is a clearing of very considerable size on this farm on which a number of the men have been given instruction in agriculture. They have also been instructed in land-clearing, logging, stumping, etc., on those portions of the farm which have not yet been fitted for the plough.

Briefly, the manner of handling the men is as follows:—Applications are listed in the Department of Lands, Forests and Mines, and from time to time the men are called up in parties of from twenty to forty for examination. Each man is examined by a competent physician to determine his physical fitness for farm work. After medical examination the applicants appear before a Committee on which is represented the Department of Lands, Forests and Mines, the Department of Agriculture, the Invalided Soldiers' Commission, the Great War Veterans' Association, the Soldiers' Aid Commission, the Canadian Patriotic Fund Committee and the Vocational Training Department. If the men pass the medical examination, and if their applications are approved by the members of the Committee mentioned above, they are deemed eligible to enter the scheme of land settlement. They are then sent forward to the colony located in the Township of O'Brien on the banks of the Kapuskasing River, where they immediately enter into the work which finally enables them to locate in their own houses on their individual holdings. At Kapuskasing they proceed to clear and fit for the plough ten acres on the front of each 100 acre lot—one lot being allowed to each prospective settler.

No charge is made for the land. During the period in which the men are engaged in clearing the ten acres on each lot, they are paid by the Department in one of two ways—either at a certain rate per hour or by contract at a certain figure per acre, determined by the conditions which attend the clearing of any particular lot.

At this point it might not be amiss to give a brief review of what has been accomplished at the Kapuskasing Colony. The Colony is situated on the east bank of the Kapuskasing River immediately south of the National Transcontinental Railway. The river is a stream of large size at this point, and the rapids which occur just at the railway bridge, add greatly to the natural beauty of the place and will doubtless ultimately figure in connection with power development. The following points might be noted:

(*a*) Nineteen frame houses of five or six rooms each have been erected in the form of a village along the east bank of the Kapuskasing River—the houses being generally occupied by returned men and their families while the necessary clearings are being made on their respective lots, and while the dwellings are being erected thereon. These houses are comfortable and are of good appearance.

(*b*) A large frame administration building and residence has been erected. This building is occupied partly as an office, and partly as a residence by some of the colony officials.

(*c*) A dormitory with a modern kitchen, dining room and recreation room has been erected. The living room is equipped with a piano, billiard table and gramophone, and an up-to-date supply of reading material is always available.

(*d*) Goods are supplied to members of the Colony from a store which has been erected by the Department. This store contains a large and well assorted stock, and goods are supplied to the members of the Colony at cost.

(*e*) A substantial frame storehouse at the terminus of the railway siding has been provided.

(*f*) A blacksmith shop has been erected and is in charge of a returned man who followed this trade previous to his enlistment.

(*g*) A large modern stable for the housing of stock has been erected on the Provincial Government farm. This farm consists of 600 acres, this land having been reserved adjacent to the village—approximately 125 acres will be placed under crop on this farm during the spring of 1919.

(*h*) A small sawmill has been erected on the east bank of the Kapuskasing River and is used in connection with the furnishing of a supply of lumber for the Colony. Lumber is disposed of to settlers at approximately cost price.

(*i*) A planing mill for the manufacturing of sash, doors, etc., has been installed and is in continuous operation.

(*j*) A modern steam laundry is in use for the benefit of the members of the colony.

(*k*) Approximately half a mile of railway siding has been constructed to connect the colony with the main line of the Transcontinental Railway. A passenger bridge over the Kapuskasing river is nearing completion.

(*l*) A modern two-roomed school, accommodating 80 pupils, has been opened, with two well qualified teachers in charge. The Public School Inspector for the district reports very favourably on the work which is being accomplished in this school. Three vans are used in conveying the pupils from their homes to the school and return. The expense of maintaining the school is, for the present, borne by the Department.

It will be understood that the men on going to the Colony leave their families in Southern Ontario. Fifty men can be housed at the dormitory, and when the men have had an opportunity to look over the situation, and have fully decided to remain with the scheme, the married members of the colony are permitted to move their families, as far as the accommodation permits, to the houses in the village.

The site of the Kapuskasing colony was selected in May, 1917, by the Minister. On July 13th, 1917, a party of four men left the Monteith Training School, in charge of Major Thos. L. Kennedy, and took up their residence at Kapuskasing. The remainder of the original party of men arrived as Kapuskasing on July 25th, 1917. Since that date, as you will note from the above, a great amount of work has been accomplished. Without going into too great detail, it might be said that good progress has been made in connection with the ten-acre clearings on the individual lots and approximately 60 settlers' houses have been erected. These houses are of substantial construction, and generally speaking cost from $500.00 to $700.00 each. Of the cost of the settlers' houses, $150.00 is borne by the Department—the balance by the settler.

Seventy horses are kept at the settlement. These horses are available for the use of the settlers, as are also farm implements, wagons, sleighs, tractors, etc. It is further proposed to maintain at the colony farm a stock of cattle, sheep and swine.

Financial assistance is available to the settlers to the extent of $500.00 to each man by way of a loan, secured by a lien on the land and chattels. Re-payment is extended over a period not to exceed 20 years, interest being charged at the rate of six per cent. per annum.

It is hoped to have all the men now at the Colony, settled in their own homes early in the spring of 1919. The completion of the ten-acre clearings will be vigorously proceeded with as weather conditions permit.

It is not proposed to issue a Patent for the holding of any individual until a period of five years from the time of his entry into the scheme has elapsed. The settler must reside on his land for at least six months in each year up to the time of the issue of Patent. Two acres must be cleared and cultivated annually—that is, the settler must clear and put under cultivation, before he can secure a Patent, ten acres in addition to the original ten acres cleared at the expense of the Crown. After being in residence for at least six months, and after

having cleared and put under cultivation two acres, in addition to the original ten acres, the timber other than pine passes to the settler. After six acres in addition to the original ten acres have been cleared and cultivated the pine timber also passes to the settler.

It is, of course, scarcely to be expected that a settler should be able to maintain his family entirely by his agricultural operations on a ten acre clearing. The land, however, is situated in the heart of the Clay Belt District, and is well wooded with spruce and other woods suitable for pulp. The removal and sale of pulpwood will afford a considerable income. A large pulp limit was recently sold in this vicinity and a large pulp mill will shortly be erected at Kapuskasing, which undoubtedly will be of inestimable benefit to the settlers. Further, there is a great amount of work to be done in connection with the building of roads, bridges, etc., so that it seems reasonable to assume that there will be an abundance of work for some time to come for such men as are willing to take advantage of same.

The following statistics are of interest in connection with the history of the scheme:

MONTEITH TRAINING SCHOOL.

Total number who passed through school	88
Total number discharged from school	1
Total number who left school voluntarily	14
Total number who went to Kapuskasing Colony from the school	73

KAPUSKASING COLONY.

Total number of men from Monteith School	73
Total number of men sent direct to Colony	100
Total number discharged from Colony	12
Total number left owing to physical unfitness	30
Total number left owing to family difficulties	19
Total number left for other reasons	29

The previous occupations of the men who entered the scheme are given as follows:

Number of farmers	26	Number of engineers	3
Number of labourers	24	Number of butchers	3
Number of carpenters	16	Number of miners	4
Number of electricians	2	Number of moulders	5
Number of bakers	3	Number of lumbermen	4
Number of blacksmiths	4	Number of teamsters	3
Number of chauffeurs	3	Number of plumbers	4
Number of mechanics	9	Other walks of life	71
Number of clerks	4		

There have entered the scheme:

Married men	141	Widowers	4
Single men	43		

Nationalities are represented as follows:

English	98	Australian	1
Scotch	14	Norwegian	1
Irish	9	American	1
Canadian	61	Manx	1
Italian	1	Negro	1

83 men remain on the scheme at date.

It may seem from the above that the number of men whose connection with the scheme has been severed, is unduly large. However, it has been found that a good number of men have found themselves physically incapable of doing the necessary work involved in the clearing of land. Two hundred and fifty-five men who had applied to enter the scheme have at various times been requested to report for examination and have failed to respond.

This scheme of Land Settlement is unique in character and affords a practical demonstration of the colony plan of settlement, a subject which has been freely discussed but apparently never before thoroughly developed.

In addition it affords a practical demonstration of the agricultural possibilities of the Great Clay Belt, especially that portion of this splendid territory lying adjacent to the National Transcontinental Railway.

It will be appreciated that in a scheme of such magnitude as promises to be the case in this instance, changes of considerable consequence will have to be made from time to time. The men now at Kapuskasing will, of course, be settled in accordance with the terms laid down in the literature pertaining to the original scheme, but it is quite possible that it might be advisable to send future parties of men into the North under slightly different conditions. One of the objects which the Department has in view is to mitigate the loneliness of pioneer life, and the colony plan of settlement is succeeding very nicely in this respect. Again, the scheme places the settler in a comfortable home with a clearing of some size, which also acts as a fire guard, within a comparatively short time from the date of his arrival in the North. The settler also has the use of horses, implements, etc., as soon as needed.

It is hoped that in the near future it will be possible to take care of applicants more quickly than is possible at the present time. The greatly increased cost of labour and supplies of every description during the past few years has operated greatly against the scheme from a financial point of view. These difficulties will no doubt right themselves in a certain measure with the coming of peace, but undoubtedly the high rate of wages prevailing has had a tendency to make the scheme somewhat less attractive and more difficult to operate, than would have been the case under normal conditions.

In conclusion, mention might be made of the services of the late Colony Superintendent, Major Thos. L. Kennedy, of Dixie, Ont., also of Lieutenant-Colonel Robert Innes, late Director of Soldiers' Land Settlement, who is now with the Soldiers' Settlement Board, Ottawa. The work of settlement has been greatly assisted by the construction of colonization roads throughout the Township of O'Brien, under the supervision of Mr. C. H. Fullerton, Superintendent Colonization Roads.

H. M. ROBBINS,
Acting Deputy Minister Lands and Forests.

Toronto, October 31st, 1918.

Appendix No. 33.

WOOD-CUTTING IN ALGONQUIN PARK.

In the early part of the year 1918 the outlook was for a severe shortage of fuel. The war was at its height. There was no prospect of an early peace. The supply of coal from the mines in the United States was with difficulty being maintained, and owing to the movement of very large numbers of troops and an immense volume of war material, transportation conditions became extremely severe.

The Dominion Government had already taken the importation and distribution of coal under its control, and restrictions were placed upon the quantity, especially of anthracite, that individuals were allowed to buy and store, no one being permitted to obtain more than 70 per cent. of his normal supply for the winter of 1918-19. In short, the universal expectation was that fuel, especially for domestic consumption, would be extremely scarce, and that considerable inconvenience and even hardship would be the result.

Under these circumstances the Ontario Government deemed it wise to supplement the supplies of fuel, and to substitute wood for anthracite in the public institutions so far as this could be done, thus releasing an equivalent quantity of anthracite coal, and making it available for domestic consumption. Accordingly, it was decided to undertake wood-cutting operations on a large scale in Algonquin Provincial Park, where extensive tracts covered with birch, maple and beech existed, the property of the Crown, within easy hauling distance of the Canada Atlantic railway. An appropriation of $100,000 was made by the Legislature to cover the cost of these operations and of other investigations into the fuel question. After public advertisement, contracts were let to the Randolph Macdonald Company, Limited, for the cutting of 10,000 cords of wood, and to B. Ivol for 6,000 cords. These were afterwards increased to 25,000 cords and 10,000 cords respectively. A wood-cutting gang was organized among the Park rangers under the direction of the Park Superintendent, G. W. Bartlett. Later in the year, in November, C. M. McConkey was also given a contract to cut in the month of December. Two railway sidings to facilitate shipment of wood were constructed at the Government's expense at Mile Posts 306 and 314 respectively, and a third siding at Algonquin Park headquarters was repaired and extended.

The privilege of cutting wood in the Park without charge was extended to the municipalities of Ontario. Several of them took advantage of the offer, and the cities of Hamilton, Kitchener, Barrie and Guelph and the town of Mimico let contracts for the cutting of considerable quantities of wood, aggregating some 10,000 or 11,000 cords. These operations were entirely distinct from those of the Government.

Owing to the unusually mild weather in the early part of the winter of 1918-19, continuing throughout January and even into February, and also to the cessation of the war by the signing of the armistice on the 11th of November, the fuel situation was materially modified. As compared with a winter of ordinary severity there has been a general saving of coal. Importations have been coming forward, and the coal dealers are now in a position to supply their customers with all their requirements without difficulty.

There was no longer the same necessity for cutting wood in Algonquin Park. The prices of labour, provisions and supplies generally were very high, and consequently the wood cutting operations have been expensive, the contract price being

$6.75 per cord loaded on the cars in the Park. The freight charges work out to between $3 and $4 per cord on wood delivered at Toronto, Hamilton or similar points. The orders for wood from the Government institutions amounted to about 2,100 cords. This has all been shipped out, and by the end of January about 14,000 cords of wood remained in the Park. This, if the weather is favourable in the months of February and March, will all be hauled out and piled at the railway sidings before the snow goes away in the spring, so that it will be available for shipment during the coming season. The wood will have an opportunity to be seasoned, and will lose in weight, thus reducing the freight charges.

All cutting under contract was stopped at the end of January, and the headquarters gang will finish by the end of February.

T. W. Gibson,

Deputy Minister of Mines.

Appendix No. 34.

Fuel Supply—Wood-cutting Permits to Municipalities.

In order to relieve the fuel situation the Department decided to grant permits to the Municipal Authorities to cut wood for the use of the citizens on lands of the Crown. Our agents were instructed to select areas upon which wood was chiefly suitable for the fuel purposes and only dry or fire killed timber was allowed to be cut for this purpose, and no sawlog timber was to be taken. The wood was to be free of Crown dues. It was the purpose of the Department, in issuing permits to municipalities, rather than to private individuals to make it possible for the citizens to obtain their fuel supply at the least expense.

A number of Municipalities availed themselves of this and made applications through the Crown Timber Agent for permits. Permits were granted to the Municipal Authorities of the Town of Kenora for an aggregate of 8,000 cords of wood, areas being selected by the Municipal Authorities and approved of by the Crown Timber Agent.

The Town of Keewatin was granted a permit covering 500 cords.

The Cities of Fort William and Port Arthur were each granted seven permits for a number of areas and locations, upon which they were allowed to cut the dry and fire killed wood.

The Municipal Authorities of Sault Ste Marie, were granted a permit tc cut on lots 10 and 11 in the 6th Concession of Jarvis, an aggregate of 5,000 cords.

The Towns of Webbwood, Fort Frances, Blind River, Cobalt, North Bay, Thessalon and Haileybury applied for and were granted permits to cut sufficient wood to meet the requirements of their citizens.

John Houser,
Chief Clerk.

Albert Grigg,
Deputy Minister.

TWENTY-SEVENTH ANNUAL REPORT

OF THE

ONTARIO BUREAU OF MINES, 1918,

BEING

VOL. XXVII

AND CONTAINING PARTS I, II AND III

PART I

CONTENTS OF PART I

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1918

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LETTER OF TRANSMISSION

To His Honour Sir John Strathearn Hendrie, C.V.O.,

Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honour to transmit herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Twenty-seventh Annual Report of the Bureau of Mines.

I have the honour to be, Sir,

Your obedient servant,

G. H. Ferguson,

Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines,
Toronto, 1918.

INTRODUCTORY LETTER

To the Honourable George Howard Ferguson, K.C.,

Minister of Lands, Forests and Mines.

Sir,—I have the honour to submit to you herewith, for transmission to His Honour the Lieutenant-Governor in Council, the Twenty-seventh Annual Report of the Bureau of Mines, being for the year 1917.

The Report consists of three Parts. Part I contains the customary Review of the Mining Industry of Ontario for the past year, with statistics of production for the several metallic and non-metallic substances, and a variety of tables giving particulars regarding them. The Review shows that the aggregate value of the output in 1917 was the greatest yet recorded; also that the tendency noted in previous Reports, towards the establishment of refining processes and facilities for manufacturing secondary products, is steadily becoming more marked. With the advantages of ample supplies of raw materials, cheap electric power, and efficient transportation, there is no reason why Ontario should not speedily develop a full-bodied metallurgical and chemical industry, and good progress has already been made to this end.

The Statistical Review is followed by a chapter on Mining Accidents in 1917 by T. F. Sutherland, Chief Inspector of Mines.

Messrs. Sutherland, Collins and Stovel report on the mines, quarries and metallurgical plants in operation during the year.

Arthur L. Parsons, who examined the Slate Islands in Lake Superior, gives an account of the geology of the Islands, and of the veins which attracted considerable attention a number of years ago, but failed to realize the hopes of mineral wealth entertained regarding them.

Mr. Parsons also deals with Mineral Developments in Northwestern Ontario, including the working and opening up respectively of copper deposits at Tip Top mine and near Mine Centre, also with diamond drilling on the titaniferous iron ores of the so-called Fetiva range on the northwest shore of Bad Vermilion lake.

Ogahalla to Collins on the National Transcontinental Railway is the title of a descriptive account by Percy E. Hopkins of the geology of a section of that railway line 175 miles in length from Kenogami river westward to Trout lake, about 35 miles west of Lake Nipigon. The line thus examined connects the great Clay Belt of Northern Ontario where it thins out on the west, with the rocky region into which it merges on the way to the Manitoba boundary. In addition, Mr. Hopkins made some reconnoitering trips into the unexplored territory in the vicinity of Armstrong, a divisional point on the railway.

Mr. Hopkins also contributes Notes on Lake Abitibi Area, having during the latter part of the field season of 1917 examined a considerable part of the shore line of that lake and many of the islands therein, as well as the country adjacent to several of its tributaries, and an area in Rickard township, in all of which localities the rock formations are favourable for mineral deposits and at a number of points have disclosed promising shows of gold.

The Matachewan Gold Area, where gold was found in the autumn of 1916, is described by A. G. Burrows, and the geology of the neighbourhood of the discovery is shown on the map accompanying his Report. For the convenience of prospectors and others interested in the development of this field, an advance edition of Mr. Burrows' Report was issued early in 1918, as Bulletin No. 34.

In Part II, under the title, Sand and Gravel in Ontario, there is a description by counties of many of the detrital deposits which play so useful a part for road and other construction purposes. The author, Auguste Joseph Gaston Ledoux, was professor of mineralogy at the University of Brussels, Belgium, when the great European war broke out. Enlisting in the Belgian army, Professor Ledoux assisted in defending his country against the invading Germans, and was seriously injured in action. Forced to retire from military service, he came to Ontario was taken on the staff of the University of Toronto in 1915 as special lecturer in mineralogy, and was subsequently employed by the Bureau of Mines in investigating these surface deposits. Prof. Ledoux spent the field season of 1917 in southern or older Ontario, to which the account in Part II is mainly confined. It was proposed also to cover the sands and gravels of northern or newer Ontario, in so far as present transportation facilities and knowledge of the territory made this possible. Professor Ledoux had begun work on the northern areas and had made some headway, when further progress was stopped by his sudden death at Sudbury on 7th August, 1918. His treatment of the subject, Sands and Gravels, deals not only with the occurrences, but with the quality and availability of the various deposits for economic uses, such as building, glassmaking, moulding, etc.

Part III, Cobalt; Its Occurrences, Metallurgy, Uses and Alloys, presents the results of an investigation into the properties of the metal cobalt, by C. W. Drury, Professor of Metallurgical Research, Queen's University, Kingston, Ontario. Section I deals with cobalt deposits, the metallurgical processes for recovering the metal from its ores, and the various uses in which it is or may be employed. In Section II there is a study of the effects of cobalt when alloyed with a variety of other metals. In view of the fact that at present the silver-cobalt ores of Ontario furnish the greater part of the world's supply of this metal and the probability that they will continue to do so for some time to come, it seems appropriate to add the results of Professor Drury's researches to the present stock of available information on this subject.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,

Deputy Minister of Mines.

BUREAU OF MINES,
DEPARTMENT OF LANDS, FORESTS AND MINES,
Toronto, 1918.

STATISTICAL REVIEW

of the

MINERAL INDUSTRY OF ONTARIO FOR 1917

By Thos. W. Gibson, Deputy Minister of Mines

In money value the output of the mineral industry of Ontario in 1917 exceeded that for 1916 by 10.3 per cent., being $72,093,832, as compared with $65,303,822. This is the highest figure yet reached for any year. Examination of the statistics makes it plain that the increased value is due more largely to higher prices than to greater production. The effect of the war has been to raise the price of practically every mineral product, with the solitary exception of gold. Increased demand and higher cost of production, both in the main due to the war, have combined to enhance the value of all the items on the list, especially of those substances required for direct use in warfare. In the case of an essential such as copper, the government of the United States deemed it necessary to intervene in order to prevent the price rising beyond all bounds. On the other hand, gold, though sharing to the full in the greater expense of production, was, because of being itself the standard of value, denied the benefit of an increase in price. The natural effect upon the gold mining industry has been to decrease the output, the number of ounces won in 1917 being 76,940 less than in 1916. Silver offers a strong contrast. A small diminution in output was more than offset by a decided advance in price, in consequence of which the mining companies of Cobalt received $16,183,208 for 19,479,692 fine ounces, while in 1916 their return for 20,007,367 ounces was only $12,703,591. Of the other items in the metallic list, cobalt, nickel, iron ore exported, pig lead and molybdenite show substantial increases in value as compared with 1916, while copper, "other" nickel and cobalt compounds, and pig iron from Ontario ore, as well as gold, show decreases due to smaller output. The net result, so far as metallic substances are concerned, is an increase of $1,828.939.

Non-metallic products show in the aggregate a heavy increase in value, amounting to $4,961,071 or 48 per cent., compared with 1916, and in most of the items the larger value was accompanied by an increased production. This is true of arsenic, feldspar, fluorspar, iron pyrites, lime, natural gas, quartz, salt, stone, and talc. For this enlarged output the war was in the main directly or indirectly responsible. Iron pyrites, for instance, was in strong demand to take the place of native sulphur, the supply of which from Sicily to this continent was entirely cut off. The requirements of the steel-making trade for fluorspar brought the Madoc deposits into active operation. More natural gas was used by the munition manufactories of southwestern Ontario. Salt for essential chemical products; arsenic for insecticides to protect precious supplies of growing vegetables and fruit; lime for metallurgical use; talc to take the place of the hitherto imported product; all these and other materials were required in increased quantities, both on this side and on the other side of the boundary line in carrying on the essential work of winning the war.

Table I, which follows, summarizes the statistics of mineral production for 1917, including the number of employees engaged in the several branches of the industry, and the wages paid them:—

TABLE I.—MINERAL STATISTICS OF ONTARIO FOR 1917

Product.		Quantity.	Value.	Employees.	Wages.
METALLIC.			$		$
Gold	ounces	420,893	8,698,735	2,939	3,588,983
Silver	"	19,479,692	16,183,208	2,692	3,011,680
Copper	lbs.	539,540	118,772	115	84,653
Copper in matte (a)	tons	21,197	7,842,890	3,356	5,570,587
Nickel in matte (a)	"	41,887	20,943,500		
Iron ore (exported) (b)	"	136,343	483,690	475	493,078
Pig iron (c)	"	49,485	1,016,699	2,895	4,339,136
Cobalt (metallic)	lbs.	396,395	589,290		
Cobalt oxide	"	418,703	533,489		
Nickel "	"	23,748	6,533		
Nickel (metallic)	"	225,480	91,923	391	542,925
Other Nickel and Cobalt compounds	"	393,036	42,026		
Molybdenite (concentrates)	"	77,517	108,501	196	116,382
Lead (pig)	"	1,772,512	172,601	121	85,528
Total metallic			56,831,857	13,180	17,832,952
NON-METALLIC.					
Actinolite	tons	120	1,320	....	....
Arsenic (white, grey and other forms)	lbs.	5,183,145	608,483	(d)	(d)
Asbestos	tons	10	2,150	18	3,000
Brick (sand-lime)	M	9,079	87,159	71	37,110
" (fancy and pressed)	"	36,233	474,614	407	206,844
" (common)	"	68,214	713,824		
Tile (drain)	"	15,940	546,040	909	473,375
" (building)	"	3,933	301,688		
Cement (Portland)	bbls.	2,063,231	2,934,271	589	538,355
Corundum	tons	188	31,213	46	33,817
Feldspar	"	18,334	81,802	136	67,182
Fluorspar	"	4,327	66,474	56	29,582
Graphite (refined)	"	3,173	296,587	156	120,053
Gypsum (crushed, ground and calcined)	"	48,943	130,138	70	59,966
Iron pyrites	"	286,049	1,111,264	580	583,819
Lime	bush.	2,820,507	657,364	325	262,132
Mica	tons	435	92,453	88	48,490
Natural gas	M. cu. ft.	20,026,000	3,220,123	783	537,946
Petroleum (crude)	Imp. gals.	7,104,700	475,000	(e) 79	(e) 75,670
Pottery			94,501	41	35,318
Quartz	tons	176,993	358,674	217	165,032
Salt	"	138,909	1,047,707	312	234,925
Sand and gravel	cu. yds.	1,187,973	431,597	417	232,971
Sewer pipe			378,923	202	168,421
Stone, (building, granite, trap, etc.)			939,052	652	475,794
Talc (crude and ground)	tons	16,076	179,554	56	49,734
Total non-metallic			15,261,975	6,210	4,439,536
Add metallic			56,831,857	13,180	17,832,952
Grand total			72,093,832	19,390	22,272,488

(a) Copper valued at 18½ and nickel at 25 cents per pound in the matte.
(b) Total production of iron ore 176,833 tons.
(c) Production from Ontario iron ore only. Total pig iron production 691,233 tons, value $14,201,695.
(d) Included with cobalt and nickel compounds.
(e) Employees and wages for proportion of domestic crude petroleum distilled in Ontario oil refineries.

Table II gives for the last five years the value of the production of the various metals, minerals, and mineral products. The figures show that the metallic output has increased in value during the period by 51 per cent., while the non-metallic production in 1917 was a little less in value than in 1913. The latter fact is due to the very heavy falling off in the manufacture of construction materials which followed the outbreak of the war. There are symptoms that this depression of the building and allied trades is beginning to be lifted, and in the meantime the expansion of other branches of non-metallic mining has practically made good the loss.

TABLE II.—VALUE OF MINERAL PRODUCTION, 1913 TO 1917.

Product.	1913	1914	1915	1916	1917
	$	$	$	$	$
METALLIC:					
Gold	4,558,518	5,529,767	8,501,391	10,339,259	8,698,735
Silver	16,579,094	12,795,214	12,174,312	12,703,591	16,183,208
Cobalt	420,386	546,479	(a) 379,657	(a) 762,327	(a) 1,122,779
Copper	1,840,492	2,081,332	3,926,018	8,365,255	7,961,662
Nickel	5,250,803	5,136,804	(b) 17,042,230	(b) 20,685,564	(b) 21,041,956
Other Nickel and Cobalt compounds	....	45,189	9,227	60,956	42,026
Iron ore (exported)	138,750	169,427	171,345	342,700	483,690
Pig iron	8,719,892	7,041,079	(c) 1,891,400	(c) 1,646,010	(c) 1,016,699
Lead (pig)	....	....	....	70,863	172,601
Molybdenite	....	....	14,099	26,393	108,501
Metallic production	37,507,935	33,345,291	44,109,679	55,002,918	56,831,857
NON-METALLIC:					
Actinolite	....	....	....	....	1,320
Arsenic	64,146	116,624	148,379	200,103	608,483
Asbestos	....	....	....	100	2,150
Brick, common and sand-lime	3,452,352	2,336,207	763,591	509,559	800,983
Brick, paving, fancy, etc.	243,119	237,440	158,515	318,942	474,614
" pressed	919,741	656,944	217,350		
Calcium carbide	123,100	142,883	(d)	(d)	(d) ....
Cement, Portland	4,105,455	2,931,190	2,534,537	2,242,433	2,934,271
Corundum	137,036	65,730	31,398	8,763	31,213
Feldspar	67,142	55,686	47,031	42,159	81,802
Fluorspar	....	....	....	10,146	66,474
Graphite	93,054	87,167	115,274	249,586	296,587
Gypsum	92,627	221,175	190,422	116,206	130,138
Iron pyrites	171,687	264,722	353,498	471,807	1,111,264
Lime	390,600	333,407	244,953	265,356	657,364
Mica	55,264	40,402	33,490	55,407	92,453
Natural gas	2,362,021	2,346,687	2,622,838	2,404,499	3,220,123
Peat fuel	1,750	2,100	....	....	....
Petroleum (crude)	398,051	337,867	300,219	387,846	475,000
Phosphate of lime	....	3,150	....	....	....
Pottery	52,875	25,720	49,387	87,025	94,501
Quartz	130,860	82,544	142,354	223,514	358,674
Salt	474,372	498,383	585,022	700,515	1,047,707
Sand and gravel	233,567	151,909	178,288	470,963	431,597
Sewer pipe	600,297	571,756	361,283	216,749	378,923
Stone, building, crushed, etc.	1,137,153	1,088,862	651,593	755,313	939,052
Talc, crude and ground	125,340	74,583	85,325	111,489	179,554
Tile, drain	292,767	277,530	321,253	275,471	546,040
" building	....	....	....	(e) 176,953	(e) 301,688
Non-metallic production	15,724,376	12,950,668	10,136,000	10,300,904	15,261,975
Add metallic production	37,507,935	33,345,291	44,109,679	55,002,918	56,831,857
Total production	53,232,311	46,295,959	54,245,679	65,303,822	72,093,832

(a) Cobalt oxide and metallic Cobalt.
(b) Nickel in matte, oxide and metallic Nickel.
(c) The product of Ontario ore only.
(d) Raw materials not all produced in Ontario.
(e) Included in former years with fancy and paving Brick.

The steady growth of the mineral industry of the Province is seen by comparing the value of the production by five-year periods since 1891, the date at which the Bureau of Mines was brought into existence. Following are the figures:—

Year.	Value Production. $	Growth per cent.
1891....................	4,705,673	
1896....................	5,235,003	.........11.2
1901....................	11,831,086	........125.9
1906....................	22,388,383	.........89.2
1911....................	41,976,797	.........87.4
1916....................	65,303,822	.........55.5

As the figures show, the growth was continued into 1917, the total production being worth $72,093,832, or 10.3 per cent. above that of 1916.

Table III shows the value of the various metals and metal-bearing substances produced in Ontario from the time mining began down to the end of 1917. As will be noted, silver holds the first place, followed by nickel, pig iron, gold and copper, in the order given. Owing to a change in the method of compiling these statistics, pig iron since 1914 comprises only the pig product of Ontario ore smelted in the Province, and iron ore only ore exported. Including all pig iron produced in the Province regardless of the place of origin of the ore, and in iron ore all the domestic ore mined, whether smelted here or exported, the totals for pig iron and iron ore respectively would be $102,859,096 and $9,869,864.

TABLE III.—TOTAL PRODUCTION OF METALS IN ONTARIO.

Metal.	To end of 1916.	1917	Total Production.
	$	$	$
Gold	33,663,648	8,698,735	42,362,383
Silver	151,428,500	16,183,208	167,611,708
Platinum and Palladium (*a*)	290,755	....	290,755
Cobalt (*b*)	3,180,990	1,122,779	4,303,769
Nickel (*c*)	89,128,164	21,041,956	110,170,120
Other Cobalt and Nickel Compounds	115,372	42,026	157,398
Copper	33,452,628	7,961,662	41,414,290
Iron Ore (*d*)	8,193,881	483,690	8,677,571
Pig iron (*e*)	76,544,482	1,016,699	77,561,181
Lead	188,153	172,601	360,754
Zinc	92,410	....	92,410
Molybdenum	42,167	108,501	150,668
Total	396,321,150	56,831,857	453,153,007

(*a*) Figures incomplete.
(*b*) Includes metallic contents of Cobalt oxide.
(*c*) Includes metallic contents of Nickel oxide.
(*d*) From and including 1915 only ore exported.
(*e*) From and including 1915 only product of domestic ore.

The War and the Mineral Industry

The influence of the war on the mineral industry of the Province was discussed in the last Report of the Bureau, and it will now suffice to say that the effects there mentioned are still in evidence, and are in some directions becoming even more marked. For instance, the margin between profit and loss in gold mining is growing narrower, and in some properties has disappeared altogether. The high cost of labour, the difficulty of obtaining it in sufficient quantity and of the proper quality, and the steadily increasing prices of supplies, have united in raising the cost of production to a point where self-interest suggests that it would be better to suspend operations until more normal conditions return. In mines of lower grade, considerations of this kind have become very urgent, and some of the owners have felt impelled to close. They have not seen the wisdom of continuing to operate at a loss, and have decided that the prudent course is to leave the ore in the mine in the hope of being able to extract it at a profit some time in the future. How far this process will extend, it is impossible to say. So long as gold remains the basis of our monetary system, so long will it be essential to maintain a sufficient supply, and in sacrificing some part of their profits in remaining in operation, those companies which do so are acting a patriotic part.

In another and quite different direction, the war is telling against the mining industry. Assiduous and intelligent prospecting for new mineral areas and ore bodies is essential to the maintenance, not to say the progress, of mining. Now, very many of the best and most capable prospectors have gone overseas to fight the King's enemies, and their absence is being felt. Gold and silver mines are not like farms, and cannot be worked for ever, or even for many years. There must be a constant succession of new properties to take the place of those being exhausted, otherwise the industry will languish. The pre-Cambrian formations of northern Ontario have already given such proof of their mineral riches that there can be no doubt many valuable metal deposits remain undiscovered. It is to be hoped that when the victory for freedom and civilization has finally been won, many of the gallant men who laid down the prospector's pick for the rifle will return to their native heath and once more fare forth into the wilderness to find the treasures which it hides.

On the other hand, the demands of the war have greatly stimulated the production of certain minerals, and practically given rise to new mining industries. An essential in the manufacture of explosives, as, in fact, of chemicals of almost any kind, is sulphuric acid. Since the stoppage of supplies of free sulphur from Sicily, the product of Louisiana and Texas has not been sufficient for the tremendous demand for sulphuric acid from the munition plants of the United States, and the lack is being in large part supplied by the importation of iron pyrites from Ontario. The principal producer is the Nichols Chemical Company, Limited, whose mines are at Northpines and Goudreau, north of Lake Superior; also at Sulphide, in the county of Hastings, where it operates an acid plant. The production of pyrite rose from 145,315 tons in 1916 to 175,593 tons in 1917, most of which was exported to the United States. It is expected that about one-third of the total requirements of pyrite in the U.S. for 1917, or, say 400,000 tons, will be obtained in Ontario.

Another mineral which has sprung suddenly into active demand is fluorspar, which is used as a flux in steel-making. There are a number of deposits near

Madoc, in Hastings county, and as the price has risen from $4 or $5 to about $30 per ton, strenuous efforts are being made to meet the demand, and a considerable proportion of the known deposits have been opened and are being worked.

Molybdenite, to take the place of tungsten in the manufacture of special steels for tool-making and other purposes, has also come into prominence during the past four years. A number of molybdenite showings have been developed and a considerable quantity of concentrates produced. Ferro-molybdenum has also been made at Orillia and Belleville in the electric furnace. An account by A. L. Parsons was given in the Bureau's last Report of the principal occurrences of molybdenite in the Province.

Nickel and copper are, of course, prime requisites in modern warfare, and the capabilities of the Sudbury mines were taxed during the past year to supply the demand. Production had reached its maximum in 1916, and the output last year was practically on the same level, being 41,887 tons of nickel and 21,197 tons of copper in the matte, as against 41,299 tons of nickel and 22,430 tons of copper in 1916.

The conditions under which the mining industry is at present being carried on are perhaps more difficult than at any previous time. The extreme scarcity of labour caused by the withdrawal of so large a proportion of working miners and labourers continues to hamper operations, and there is little relief in sight except what may result from the slackening of operations in the gold fields. The bulk of the labour actually employed in mining is of foreign origin, not a little of it indeed alien enemy in character. It does not appear that any large proportion of this enemy labour is actively hostile, but the presence in our mines and mills of so many workmen who, technically at least, are the enemies of our country, cannot be regarded as a satisfactory feature. The mining industry is essential to the carrying on of the war, since it provides the raw materials for weapons and munitions, and the metals required for financing the struggle. No doubt a recognition of this fact reconciles a good many people to a spectacle which would otherwise be intolerable—that of enemy workmen employed at large wages while patriotic Canadians are risking their limbs and lives at very much smaller pay.

It will be remembered that in May, 1917, on account of the dearth of labour, and to enable prospectors and claim-holders to remain at work in the mines, an Order-in-Council was passed permitting the postponement of assessment work on mining claims for twelve months. The provisions of this order were largely taken advantage of, and the result was that in 1918 two instalments of assessment work fell due on many claims, namely, the instalment for 1917 and also that for 1918. To ease the situation, in June, 1918, another Order was passed declaring it unnecessary in such cases to do more than the work postponed from last year, and also moving forward for twelve months the period for performing any subsequent instalment or instalments of work.

The high and steadily mounting cost of supplies of all kinds, and the delays attendant upon the procuring of machinery, are also embarrassing the mining industry in common with others. The peremptory and enormous demands of the war for steel and iron must first of all be met, and only what remains can be diverted to peaceful industries. While so large a proportion of the manufacturing plants both of Canada and the United States are engaged in making munitions of war, this difficulty of obtaining mining machinery and plant will necessarily

continue. Coal is also required at many mining properties for heating and at some for power, and the coal situation is certainly not all that could be desired. However, electric energy generated hydraulically is now so generally used for the operation of mines and works in Ontario that the scarcity of fuel is not so serious in mining as in many other industries.

The operation of the taxation laws, Dominion and Provincial, has not borne with undue harshness upon mining. In both cases profits are the basis of the tax, and if no profits are realized no taxation is imposed. In addition, the Dominion taxing regulations permit allowance to be made for exhaustion of the mine, which materially reduces the amount of the tax. Except in the case of nickel-copper mines, and also where profits exceed one million dollars per annum, the Ontario tax remains at 3 per cent. of the net profits. The Canadian Copper Company contested the constitutionality of the amendments of 1917 to the Mining Tax Act of Ontario, and applied to the Government of Canada to disallow it. Argument was heard by the Government in the matter, but it declined to interfere.

Gold

The production for 1917 was 420,893 fine ounces, being 76,940 ounces or about 15 per cent. less than in 1916. The causes of this decrease have already been mentioned, the principal, if not the only one, being the greatly increased cost of production of an article whose price is fixed. All but about 6 per cent. of the gold was obtained from the mines of Porcupine. Here the leading producer was the Hollinger, followed by the McIntyre, Dome, Porcupine Crown, Porcupine V.N.T., and Schumacher, in the order named. Dome Lake made a small production, and there was a little gold obtained at one or two other prospects under development. At Kirkland Lake, Tough-Oakes was joined during the year as a producer by Teck-Hughes. The only other productive property of account was the Crœsus, which won some 2,837 ounces of gold from 1,541 tons of ore. In Table IV, given below, will be found particulars of the gold production for 1917:—

TABLE IV.—GOLD MINING IN 1917.

Mine.	Tons Ore milled.	Gold Product.		Silver Product.		Total Value.	Extraction per ton	Dividends in year.
		Fine ounces.	Value.	Fine ounces.	Value.			
			$		$	$	$ c.	$ c.
Porcupine—								
1. Dome	359,570	71,193	1,471,705	10,659	8,469	1,480,174	4 12	300,000 00
2. Dome Lake	16,388	2,166	44,291	176	143	44,434	2 61	....
3. Hollinger	514,801	204,810	4,233,777	34,886	28,161	4,261,938	8 29	738,000 00
4. McIntyre	175,893	81,827	1,696,126	17,536	14,078	1,710,204	9 73	541,542 45
5. Newray	840	70	1,440	9	7	1,447	4 26	....
6. Porc. Crown.	39,111	18,180	375,766	2,637	2,138	377,904	9 66	120,000 00
7. " V.N.T.	34,971	10,416	208,350	1,705	1,388	209,738	5 99	....
8. Schumacher	37,323	9,551	197,413	1,491	1,192	198,605	5 32	....
9. Tommy Burns & Gold Reef	31	44	876	1	1	877	....	....
Kirkland Lake—								
10. Teck-Hughes	11,257	3,181	65,753	1,155	969	66,722	5 44	....
11. Tough-Oakes.	38,695	16,384	338,593	5,257	4,237	342,830	8 86	....
Miscellaneous—								
12. Cordova	860	29	593	....	....	593	(a)	....
13. Crœsus	1,541	2,837	59,820	281	226	60,046	38 97	....
14. Rognon	40	14	279	....	....	279	6 97	....
15. St. Anthony	....	94	1,944	26	23	1,967	....	....
16. Small Producters	3	43	884	404	242	1,126	5 89	....
17. Copper Ore	....	54	1,125	....	....	1,125	....	....
Total	1,230,324	420,893	8,698,735	76,223	61,274	8,760,009	7 12(b)	1,699,542 45

(a) Over $3,000 in gold lost in fire.
(b) Average of 1 to 16 inclusive, omitting Nos. 12 and 15.

Development work is going on in several of the newer gold areas, and the prospect is that ere long some of these properties will contribute to the output of gold. At Boston Creek, the Patricia syndicate took over the Boston-Hollinger claim in August 1917, and by the end of the year had power plant installed and the necessary buildings erected. Two shafts had been sunk, 110 and 90 feet respectively in depth, and it was proposed to erect a 40-stamp mill. In this camp also the Miller Independence Mines, Limited, installed a standard Ball mill, with amalgamation and oil-flotation treatment of concentrates.

At Kirkland Lake there was a good deal of activity. Lake Shore Mines, Limited, built a mill of approximately 60 tons per day capacity, and expected to have it in operation in March, 1918. It is of the ball-and-tube grinding type, with continuous counter-current decantation process for gold recovery. Kirkland Lake Gold Mining Company, Limited, also had a gold mill in course of construction. The Wright-Hargreaves Mines, Limited, continued sinking and developing operations, employing a force of about 50 men.

The mill at the Dome mine, Porcupine, operated for most of the year, but closed down at the end of November, the cost of production having risen to a point where operations were unprofitable. Underground work, however, was continued.

The Canadian Exploration Company, at Long Lake, did some diamond-drilling in the early part of the year, and a little experimental work on tailings, but later closed the mine entirely.

Following is a list of the producing gold mines, with the post-office address of the manager, etc.:—

PRODUCING GOLD MINES, 1917.

Name of Company.	Name of Mine.	Locality.	P.O. Address of Manager, etc.
Cordova Mines, Limited	Cordova	Eastern Ontario.	Toronto.
Crœsus Gold Mines, Limited	Crœsus	Munro tp.	Matheson.
Crown-Newray Company	Newray	Porcupine	Timmins.
Dome Mines Co., Limited	Dome	Porcupine	
Dome Lake Mining and Milling Company, Limited	Dome Lake	Porcupine	South Porcupine.
Hollinger Consolidated Gold Mines, Limited	Hollinger	Porcupine	Timmins.
McIntyre-Porcupine Mines, Limited	McIntyre	Porcupine	Schumacher.
Porcupine Crown Mines, Limited	Porcupine Crown	Porcupine	Timmins.
Porcupine V. N. T. Gold Mines, Limited	Vipond-North Thompson	Porcupine	Timmins.
Rognon Gold Mines, Limited	Rognon	Wabigoon Lake.	Dryden.
Schumacher Gold Mines, Limited	Schumacher	Porcupine	Schumacher.
Teck-Hughes Gold Mines, Limited	Teck-Hughes	Kirkland Lake.	Kirkland Lake.
Thunder Mining Company, Limited	St. Anthony	Sturgeon Lake	St. Anthony Mine.
Tough-Oakes Gold Mines, Limited	Tough-Oakes	Kirkland Lake	Kirkland Lake.

The gold production of the Province and of the Porcupine area respectively, for the last seven years, are given in the table appended. As the figures show, the Porcupine mines have supplied very much the larger share of the total.

GOLD PRODUCTION, 1910-1917.

Year.	Total Production. $	Porcupine. $	Percentage from Porcupine.
1910	68,498	35,539	51.8
1911	42,637	15,437	36.2
1912	2,114,086	1,730,628	81.8
1913	4,558,518	4,294,113	94.1
1914	5,529,767	5,190,794	93.8
1915	8,501,391	7,536,275	88.6
1916	10,339,259	9,397,536	90.8
1917	8,698,735	8,229,744	94.5

On a later page will be found Table V. which shows the dividends which have been declared by the gold mining companies in Ontario up to the end of 1917. It will be seen that for last year the amount so declared was $1,699,542.45, and for the full period, $11,486,167.45.

The Case of the Gold Mining Industry

For the immediate future the outlook is for a diminution of the gold yield of the Province, but this by no means reflects upon the capability of the producing areas, new or old. It is simply the result of economic conditions, a suspension, not a cessation, of activity, and at the worst only partial. In the long run the expenditure of money in operating an unprofitable enterprise must result in lessening the stock of capital employed in the industry, and from this point of view is economically unsound.

But there is little room to doubt that with the return of peace there will come a renewal of vigorous life in the gold mining camps of the North. The colossal expenditures of the belligerent nations during the period of the war have far outstripped the ability of the gold reserves of the world to finance them, measured by any customary pre-war basis. These reserves have been computed roughly to amount to $10,500,000,000, or, say, 17,000 tons of gold. Practically all the combatant nations, Italy excepted, have a single standard for their financial basis, namely, gold. Hence the debts which all have so lavishly contracted, and are still contracting, are nominally payable in this metal. But the entire gold reserves of the world, instead of representing about 35 per cent. of the total indebtedness of the warring nations, as they did before the beginning of the conflict, now amount to only about 8 per cent. Consequently, the ability of any nation to obtain funds for war expenditures now depends much less than formerly upon the amount of gold which it possesses or controls, and rests in fact almost wholly on its credit. This in turn is based upon its previous financial record, and its present and potential resources. Yet all the borrowings, and the interest annually accruing upon them, are payable in gold, and hence the necessity imposed upon the borrowers to provide themselves with this essential metal. As gold is the article in demand, among the most important assets of a nation is its gold fields, and it is reassuring to remember that Great Britain and her Allies control over 90 per cent. of the world's gold production. The gold mines of the British Empire alone annually provide about 62 per cent. of the entire yield, which in 1917 is estimated at about £96,700,000.

The favourable trade position occupied by the United States after the war began and up to the time when she too was constrained to throw her sword into the

scale, enabled her to increase her share of the world's monetary stock from about one-fifth to nearly one-third; the coin and bullion used as money in that country on November 1, 1917, being estimated at $3,041,500,000. As a matter of practical experience neither the world stock of gold or of silver, nor both combined, has proven sufficient to meet the necessities of trade and finance occasioned by the war, and the strain upon these metals has had in every country to be relieved by the issue of paper currency. One of the first war acts of the British Government was to print, in August, 1914, one-pound and ten-shilling notes, nothing of smaller denomination than the five-pound notes of the Bank of England having previously been in circulation in England.

Unless the changes which everyone is predicting are to follow the war, include the overthrow of our present systems of exchange and the substitution of some other basis for that of gold, the demand for that metal will continue, and will probably become greater than ever. Should the cost of labour and supplies fail to drop to a level at which low grade mines again become profitable, the nations may have to face the question whether, on the ground of public necessity, they should not come actively to the aid of the gold mining industry.

Silver

There was a slight falling off in the quantity of silver mined and marketed last year as compared with 1916, the quantities respectively being 19,479,692 and 20,007,367 fine ounces, a decrease of 2.6 per cent. In value, however, there was a large increase. In 1916 the return to the mining companies was $12,703,591, while in 1917 it was $16,183,208, or 27.3 per cent. more. Thus, while in 1916 the average price per fine ounce received by the mine owners was 63.49 cents, last year it was 83.07 cents. For the entire year 1917 the average price for silver in New York was 81.417 cents, as compared with 65.661 cents in 1916. The lowest monthly average price was 73.861 cents in March, and the highest 100.740 cents in September. On September 21 the price rose to $1.08 per ounce, and on September 28 the Mining Corporation of Canada is stated to have sold 200,000 ounces of silver on a basis to net the company in Toronto $1.16 7-16 per ounce. On the same day the New York price was $1.085 per ounce. These are the highest figures for silver that have been quoted for forty years. The price in London on September 21 rose to 55d. standard, the highest figure since March, 1878. It remained four days at this point, and then began to fall in a spectacular fashion, until October 23, when it reached 41⅞d., a drop of 13⅛d. in less than a month. On October 30 a rise of 3d. occurred from 43d. to 46d., the largest variation in a single day on record. Since the close of the year the United States Government has decided to melt into bullion as much as is necessary of some $400,000,000 it holds in silver dollars, and to fix the price for purchase of silver to replace them at $1.00[1] per fine ounce, thus ensuring a firm and high market for the output of the Cobalt mines.

The rapid rise in the value of silver last year was in the main due to the demand for coinage purposes by the belligerent nations, including China. The European armies are paid in silver, and huge disbursements are constantly being made to the millions of men under arms.

[1] Since increased to $1.01½.

Influence of the East

The Chinese demand arose from an effort by that country in the latter part of the summer to replace part of its currency, of which large amounts had earlier in the year been shipped abroad, chiefly to India which imported from China some 39 million ounces. China's policy of alternate buying and selling silver was largely responsible for the rapid fluctuations of price during the year. The monetary system of that country, if system it can be called, being based on silver, the rise in price of that metal greatly helped the revenue of the Chinese Government, especially in relation to payments of foreign indebtedness which had to be made in gold. In China gold is a commodity, just as silver is in other countries, and the enhanced value of silver led to an increased purchase of gold in the form of objects of art and jewellery. A large part of the imports of silver, amounting to 25 millions of ounces, came from San Francisco; London, for the time at any rate, being unable to compete with Western ports on account of the greater cost of carrying silver across the Atlantic owing to the high rates of insurance against war risk. This considerable diversion of silver from the London market contributed largely to the remarkable rise in price to 55d. per standard ounce in September.

The increased cost of commodities, which was as marked in the East as in the West, the large war expenditures and consequent stimulation of business demanded an increase in the amount of currency, and accordingly the Indian mints became very busy. During the twelve months ending March 31, 1917, the coinage of rupees,[1] half-rupees and quarter-rupees amounted to 307¾ million rupees, the equivalent of nearly 106 million fine ounces of silver. The net imports into India during this period were a little less than the silver coined, or 104,069,101 ounces, but the Government

[1] The rupee is the standard measure of value in India, and it also circulates largely in Mesopotamia, Egypt, etc. It is a silver coin weighing 180 grains, of which 165 parts are pure silver and 15 parts alloy. There are 16 annas in a rupee, and one anna equals 12 pies (or pice); 8-anna and 4-anna pieces are struck in silver, 1-anna pieces in nickel, ¼-anna, ⅛-anna and 1-12-anna pieces in bronze. The value of a rupee is one-fifteenth part of one pound sterling, or 1s. 4d., hence one anna is the equivalent of a penny. The gold standard was introduced into India in 1899, but as yet no sovereigns have been minted there. A lac (or lakh) is 10,000 rupees, and a crore is 10,000,000 rupees.

The extreme poverty of the majority of the Indian people is illustrated by an example from life given in Benjamin White's "Silver, its History and Romance" (Hodder and Stoughton, London, New York and Toronto, 1917). An agricultural labourer's family in Bengal consisted of himself (aged 18), two younger brothers aged 8 and 6 years respectively, a sister of eleven, and his wife and mother, six persons in all. The head of the household and his 8-year old brother were the breadwinners, earning 2d. per day each, the wages being paid sometimes in cash, but generally in kind. The family possessions consisted of 3 cows, value £4 10s., and some goats; their furniture of three brass dishes, a few kitchen utensils and a grindstone (flour mill), total 8s. The entire expenditure of this family for one year was £6 sterling, of which £4 15s. went for food, 15s. for clothing, and 10s. for other purposes, including 8d. for celebration of the sun-god festival. It is evident that among the 300,000,000 people whose standard of living sinks to so low a level, coins of small denomination are required in the myriad transactions of daily life, hence the circulating media are largely confined to the rupee and smaller coins. Since the war began, however, even the Hindu labourer's wages have materially increased.

In explanation of the almost uninterrupted disappearance from view of much of the silver imported into India, Mr. White says: "The Indian native is a born hoarder. Generation after generation of unrest has passed in India. Great empires in succession have risen and fallen, and the coming and going of each ruling power has been bad for the peasant. So, throughout the ages, he sank his little pile in mother earth, to be disinterred in another and perhaps happier time. 'Will the British Raj last any more than the others?' he says. 'It is true we are not ground and taxed to death as in the past; so much the better for our underground reserves.' For this operation nowadays, he prefers to secrete a portion in gold. He can better afford it; it is handier for hoarding, and it is less bulky for carrying."

was able to procure an additional £1,000,000 worth in the local bazaars. The exceptional promise of good crops in India in 1917, which promise was fulfilled, required the mints to remain at work, and coinage to the extent of 207,737,326 rupees was turned out during the year. For the six months ending September 30, 1917, the net imports into India were 42,915,610 ounces. The internal demand for silver in India for use in the arts, usually large, became very great, and to a considerable extent was met by "country bars," *i.e.,* bars made by melting down old stocks of jewellery, etc. The existing high prices tempted many people who had bought their silver jewellery in the years when prices were very much lower. to realize a profit by re-selling it as bullion. Later in 1917 the export of silver from India was prohibited, and imports were regulated by providing that none should be brought in except under license. To supplement the very large coinage of silver, the Indian Government decided upon an issue of rupee notes, thus falling in line with many of the Western nations. The prohibition by the British Government of shipments of gold to India, with the view of reducing the drafts on the all-important stocks of that metal held in England necessitated settlement of the balance of trade in favour of India to be made in silver, and this fact, together with a somewhat similar situation in China and Japan has no doubt assisted in maintaining the high level to which the price of silver has risen. The action of the United States Government in resolving to melt into bullion $400,000,000 worth of silver dollars held in reserve against silver certificates, and to place the bars upon the market as required, was very opportune in relieving the strain thrown upon the financial functions of silver in the East, where perhaps 75 per cent. of the production of the world is annually consumed.

In Europe and America, the principal feature of the silver industry was the purchase by Great Britain, France, and the United States of large quantities to be coined for payment of their troops. The continent of America being the source of over 80 per cent. of the silver annually produced in the world, and the continent of Asia absorbing over two-thirds of it, it would seem that the direct route from the Pacific coast to China and India would even in normal times offer advantages over Atlantic shipments with transfer at London. Insurance rates were high during 1917, and much more silver than usual was exported from San Francisco and Vancouver. The currents of trade once firmly established are, however. very persistent, and the control that London exercises over Eastern exchange will probably be strong enough to ensure a restoration of former conditions when peace returns.

Silver Largely a By-Product

The events which in any quarter of the world have a bearing upon the demand and price for silver, have a special interest for that branch of the mining industry in Ontario, by reason of the fact that the mines of this Province are among the comparatively few which are worked primarily for their silver contents. Probably two-thirds of the silver production of the world is obtained as a by-product of lead, copper, and zinc mines, in the ores of which silver is present in quantity worth saving, yet not usually sufficient to warrant their being worked for the silver alone. The lead, copper, or zinc would continue to be produced if the market price of the metal or metals warranted, whether silver were high in price or low,

and fluctuations in the price of the by-product metal are of comparatively little significance. In the case of Cobalt, however, silver is the paramount product, and consequently the ruling price of silver is the fact of prime importance. Because of silver being in this sense subsidiary to other metals, even a decided advance in value, such as occurred in 1917, has not the effect of increasing the output to the same extent as if it were in the main worked for its own sake only. Hence it is unlikely that the present value of silver will be reduced by a sudden and large increase of the world's output, and so long as the present urgent demand continues, it may reasonably be expected that the price will remain high.

The production of silver in the world last year is estimated at about 167,000,000 fine ounces. Of this, the United States contributed 74,244,500 ounces, and Canada 22,150,680 ounces. Mexico, which a few years ago led all the countries with a yield of over 70,000,000 ounces, has now fallen to about half that quantity, and the policy of hostility towards foreign capital invested in mining being pursued by the Government in power renders it unlikely that her former position will be soon resumed.

The production of silver in the Province last year, according to camps, was as follows:—

	Ounces.
South Lorrain	10,000
Gowganda	1,064,635
Cobalt proper	18,327,258
Silver recovered from gold and copper ores	77,799
Total	19,479,692

The mines sending out more than one million ounces of silver were:—

	Ounces.
Mining Corporation	4,546,065
Nipissing	3,794,242
Kerr Lake	2.302,466
Coniagas	1,273,853
O'Brien	1,064,335
Miller-Lake O'Brien	1,050,149
McKinley-Darragh-Savage	1,013,602

Those shipping less than a million ounces, but more than a quarter of a million were:—

	Ounces.
Temiskaming	887,122
Buffalo	645,915
La Rose Consolidated	478,639
Beaver Consolidated	462,723
Chambers-Ferland	330,063
Trethewey	311,324
Crown Reserve	309,420
Hudson Bay	277,091
Penn-Canadian	259,784

Silver and Gold Dividends

Table VII, which is appended, gives a list of the silver and gold mining companies which have paid dividends, and shows the amounts so paid, etc. In 1917 the distribution of dividends and bonuses amounted to $5,586,946.80, and in the entire period to $70,821,829.34.

TABLE V.—DIVIDENDS AND BONUSES BY GOLD AND SILVER MINING COMPANIES TO DECEMBER 31, 1917.

Name of Company.	Date of Incorporation.	Authorized Capital.	Capital Stock Issued.	Par value per share.	Amount of Dividends and Bonuses paid to end of 1916	Amount of Dividends and Bonuses paid during 1917.		Total of Dividends and Bonuses paid to Dec. 31st, 1917.	Last Dividend or Bonus. Date declared.
		$	$	$ c.	$	$ c.	%	$	
GOLD COMPANIES.									
Dome Mines Company, Ltd.	Mar. 23, 1910	5,000,000	4,000,000	10 00	1,200,000 00	300,000 00	7½	1,500,000 00	May 7, 1917
*Hollinger Consolidated Gold Mines, Ltd.	May 20, 1916	25,000,000	24,600,000	5 00	7,456,000 00	738,000 00	3	8,194,000 00	April 22, 1917
McIntyre-Porcupine Mines, Ltd.	Mar. 16, 1911	4,000,000	3,610,283	1 00	....	541,542 45	15	541,542 45	Sept. 29, 1917
Porcupine Crown Mines, Ltd.	May 26, 1913	2,000,000	2,000,000	1 00	720,000 00	20,000 00	12	840,000 00	July 15, 1917
Rea Consolidated Gold Mines	April 5, 1911	1,000,000	200,000	5 00	12,000 00	....	....	12,000 00	....
Tough-Oakes Gold Mines, Ltd.	July 15, 1913	3,000,000	2,657,500	5 00	398,625 00	....	....	398,625 00	Dec. 27, 1916
Total by Gold Companies					9,786,625 00	1,699,542 45	....	11,486,167 45	
SILVER COMPANIES.									
Aladdin Cobalt Company, Limited	Aug. 23, 1912	500,000	500,000	5 00	....	75,000 00	15	75,000 00	April 30, 1917
Beaver Consolidated Mines, Ltd.	Mar. 1, 1907	2,000,000	2,000,000	1 00	650,000 00	....	....	650,000 00	April 8, 1916
Buffalo Mines, Ltd., The	April 27, 1906	1,000,000	1,000,000	1 00	2,787,000 00	....	....	2,787,000 00	May 28, 1914
Casey Cobalt Silver Mining Company, Ltd.	Dec. 19, 1906	100,000	100,000	1 00	203,249 33	....	....	203,249 33	April 22, 1914
Cobalt Comet Mines, Ltd.	April 16, 1913	1,000,000	1,000,000	1 00	230,000 00	....	....	230,000 00	April 1, 1915
Coniagas Mines, Limited, The	Nov. 24, 1906	4,000,000	4,000,000	5 00	8,440,000 00	300,000 00	7½	8,740,000 00	Aug. 8, 1917
Crown Reserve Mining Co., Ltd.	Jan. 16, 1907	2,000,000	1,999,957	1 00	6,190,849 00	....	....	6,190,849 00	Dec. 28, 1916
Kerr Lake Mining Company, Ltd.	Aug. 9, 1905	40,000	40,000	100 00	7,128,000 00	662,000 00	....	7,790,000 00	Oct. 9, 1917
La Rose Mines, Ltd.	May 31, 1908	6,000,000	6,000,000	5 00	6,030,546 84	240,000 00	4	6,270,546 84	Sept. 11, 1917
McKinley-Darragh-Savage Mines of Cobalt Ltd.	April 17, 1906	2,500,000	2,247,692	1 00	4,943,930 46	269,723 04	12	5,213,653 50	Nov. 6, 1917
†Mining Corporation of Canada, Ltd.	Mar. 20, 1914	2,075,000	2,075,000	1 00	1,348,750 00	1,556,296 86	18¾	2,905,046 86	Dec. 15, 1917
Nipissing Mining Company, Ltd.	Dec. 16, 1904	250,000	250,000	100 00	16,288,297 25	1,935,000 00	....	18,233,297 25	Dec. 6, 1917
Penn-Canadian Mines, Ltd.	April 24, 1912	1,500,000	1,349,705	1 00	67,485 25	148,467 55	11	215,952 80	Sept. 10, 1917
Peterson Lake Silver-Cobalt Mining Co. Ltd.	April 11, 1906	3,000,000	2,401,820	1 00	420,031 50	42,031 85	1¾	462,063 35	Jan. 2, 1917
Seneca-Superior Silver Mines, Ltd.	Sept. 29, 1911	500,000	478,884	1 00	1,579,817 20	....	....	1,579,817 20	Dec. 15, 1916
Temiskaming Mining Co., Ltd.	Nov. 5, 1906	2,500,000	2,500,000	1 00	1,684,156 25	300,000 00	12	1,984,156 25	Oct. 5, 1917
Wettlaufer Lorrain Silver Mines, Ltd.	Nov. 30, 1908	1,500,000	1,416,590	1 00	637,465 50	....	....	637,465 50	Sept. 22, 1913

Trethewey Silver Cobalt Mines, Ltd.	May / June	30, 1906 / 1, 1911	2,000,000	1,000,000	1 00	1,111,998 50	50,000 00	5	1,161,998 50	Aug. 20, 1917
Right of Way Mines, Ltd.	Sept.	11, 1909	2,000,000	1,685,500	1 00	244,397 50	8,427 50	½	252,825 00	....
Right of Way Mining Co., Ltd.	July	13, 1906	500,000	500,000	1 00	324,643 93	....	....	324,643 93	....
**City of Cobalt Mining Co., Ltd.	Oct. / Jan.	5, 1906 / 7, 1909	500,000 / 1,500,000	1,500,000	1 00	145,000 00	....	....	145,000 00	April 15, 1909
Cobalt Central Mines Co., Ltd.	Dec.	13, 1906	5,000,000	5,000,000	1 00	192,845 00	....	....	192,845 00	Aug. 25, 1909
**Cobalt Lake Mining Co., Ltd.	Dec.	22, 1906	3,000,000	3,000,000	1 00	465,000 00	....	....	465,000 00	May 29, 1914
Cobalt Silver Queen, Ltd.	April	1, 1906	1,500,000	1,500,000	1 00	315,000 00	....	....	315,000 00	Dec. 31, 1908
**Cobalt Townsite Mining Co,. Ltd.	May	8, 1906	100,000	45,011	1 00	1,042,259 61	....	....	1,042,259 61	Nov. 11, 1914
Foster Cobalt Mining Co., Ltd.	Feb.	14, 1906	1,000,000	915,588	1 00	45,000 00	....	....	45,000 00	Jan. 1, 1907
Temiskaming and Hudson Bay Mining Co. Ltd.	July	29, 1903	25,000	7,761	1 00	1,940,250 00	....	....	1,940,250 00	Nov. 10, 1914
Hudson Bay Mines, Ltd.	July	16, 1909	3,500,000	3,200,050	5 00	778,909 42	....	....	778,909 42	Aug. 31, 1913
Total by Silver Companies						65,234,882 54	5,586,946 80	....	70,821,829 34	
Total dividends						75,021,507 54	7,286,489 25	....	82,307,996 79	

* Hollinger Consolidated Gold Mines Limited is a consolidation of the Acme Gold Mines Limited, Millerton Gold Mines Limited, and Hollinger Gold Mines Limited. Dividends include $160,000 paid by the Acme prior to amalgamation with the Hollinger.

† Mining Corporation of Canada, Limited, owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.

** Now owned and operated by Mining Corporation of Canada, Limited.

Table VI, which follows, shows the shipments of ore, concentrates and silver bullion from the Cobalt silver mines since they were opened in 1904. The figures take no account of inter-camp movements, but include all shipments to outside points, whether in Ontario or the United States. The diminution in raw ores sent out, and the increase of concentrates and bullion will be noted:—

TABLE VI.—SILVER PRODUCTION, COBALT MINES, 1904 TO 1917.

Year.	No. of Producing Mines.	Shipments and Silver Contents. Ore. Tons.	Ore. Oz.	Ore. Av. per ton. Oz.	Concentrates. Tons.	Concentrates. Oz.	Concentrates. Av. per ton. Oz.	Bullion. Oz.	Total. Ounces.	Total. Value. $
1904....	4	158	206,875	1,309	....	....	....	....	206,875	111,887
1905....	16	2,144	2,451,356	1,143	....	....	....	....	2,451,356	1,360,503
1906....	17	5,335	5,401,766	1,018	....	....	....	....	5,401,766	3,667,551
1907....	28	14,788	10,023,311	677	....	....	....	....	10,023,311	6,155,391
1908....	30	24,487	18,022,480	736	1,137	1,415,395	1,244	....	19,437,875	9,133,378
1909....	31	27,729	22 436,855	809	2,948	3,461,470	1,174	....	25,897 825	12,461,576
1910....	41	27,487	22,581,714	821	6,345	7,082,834	1,030	980,633	30,645,181	15,478,047
1911....	34	17,278	20,318,626	1,176	9,375	8,056,183	858	3,132,976	31,507,791	15,953,847
1912....	30	10,719	15,395,504	1,436	11,214	9,768,228	871	5,080,127	30,243,859	17,408,935
1913....	35	9,861	13,668,079	1,386	11,016	8,489,321	770	7,524,575	29,681,975	16,553,981
1914....	32	4,302	6,504,753	1,511	12,152	8,915,958	733	9,742,130	25,162,841	12,765,461
1915....	24	2,365	6,758,286	2,359	11,996	10,001,548	834	7,986,700	24,746,534	12,135,816
1916....	28	2,177	4,672,500	2,146	8,561	7,598,011	887	7,644,579	19,915,090	12,643,175
1917....	28	2,288	3,271,353	1,429	13,720	6,445,243	469	8,053,318	19,401,893	16,121,013
Total ..	....	151,568	151,712,958	1,001	88,964	71,234,197	801	50,145,038	274,724,172	151,950,561

In Table VII is shown the quantity and value of all the constituents, recoverable and recovered, in the ores of the Cobalt camp from the beginning. Until 1913 an estimate was made of the nickel, cobalt, and arsenic contents, since in few cases only were these substances paid for, and consequently no assays were made for them, but since 1914 only the actual recoveries and their money values are given. Beyond doubt in past years only a small proportion of these by-products was extracted from ore shipped to the United States, but the volume of such shipments has since been greatly reduced.

TABLE VII.—TOTAL PRODUCTION, COBALT SILVER MINES, 1904 TO 1917.

Year.	Copper.(a) Oa	Copper.(a) Value.	Nickel. Tons.	Nickel. Value.	Cobalt. Tons.	Cobalt. Value.	Arsenic. Tons.	Arsenic. Value.	Silver. Ounces.	Silver. Value.	Total Value.
		$		$		$		$		$	$
1904..	....	....	14	3,460	16	19,960	72	903	206,875	111,887	136,217
1905..	....	....	75	10,00	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906..	....	....	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907..	....	....	370	1,171	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908..	....	....	612	....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909..	....	....	766	....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
1910..	....	....	504	....	1,098	54,699	4,897	70,709	30,645,181	15,478,047	15,603,455
1911..	....	....	392	....	852	170,890	3,806	74,609	31,507,791	15,953,847	16,199,346
1912..	....	....	429	11,220	934	314,381	4,166	80,546	30,243,859	17,408,935	17,818,082
1913..	....	....	377	13,326	821	420,386	3,663	64,146	29,681,975	16,553,981	17,051,839
1914..	....	....	(b) 90	28,978	(b) 351	590,406	2,030	116,624	25,162,841	12,765,461	13,501,469
1915..	....	....	(c) 35	28,353	(c) 206	383,261	2,490	148,379	24,746,534	12,135,816	12,695,809
1916..	....	....	(c) 79	59,380	(e) 400	805,014	2,160	200,103	19,915,090	12,643,175	13,707,672
1917..	53	28,840	(e) 155	125,071	(e) 337	1,138,190	2,592	608,483	19,401,898	16,121,013	18,028,597
Total.	53	28,840	4,058	283,969	8,950	4,388,400	38,789	1,524,569	274,724,172	151,950,561	158,176,339

(a) Copper is recovered from certain silver ores and concentrates shipped to United States refineries.
(b) Metallic contents of Nickel and Cobalt oxides respectively.
(c) Metals and metallic contents of all Nickel and Cobalt compounds.

Following is a list of the productive silver properties in operation at Cobalt in 1917:—

PRODUCING SILVER MINES IN 1917.

Company or Owner.	Mine.	P.O. Address of Manager, etc.
Adanac Silver Mines, Limited	Adanac	Haileybury.
Aladdin Cobalt Company, Limited	Chambers-Ferland	Cobalt.
Angus, D. H.	Nipissing Reduction Mill clean-up	Cobalt.
Beaver Consolidated Mines, Limited	Beaver	Cobalt.
Buffalo Mines, Limited, The	Buffalo	Cobalt.
Cobalt Comet Mines, Limited	Drummond	Giroux Lake.
Cobalt Provincial Mining Co., Limited	Provincial	Cobalt.
Cobalt Silver Queen, Ltd.	Silver Queen	Cobalt.
Coniagas Mines, Limited	Agaunico Coniagas	Cobalt.
Crown Reserve Mining Company, Limited	Crown Reserve	Cobalt.
Hargrave Silver Mines, Limited	Hargrave	Cobalt.
Hudson Bay Mines, Limited	Hudson Bay	Cobalt.
Kerr Lake Mining Company, Limited	Kerr Lake	Cobalt.
La Rose Mines, Limited	La Rose	Cobalt.
McKinley-Darragh-Savage Mines of Cobalt, Limited	McKinley-Darragh, Savage	Cobalt.
Mining Corporation of Canada, Limited, The	Cobalt Lake, Townsite-City	Cobalt.
National Mines, Limited	National	Cobalt.
Nipissing Mining Company, Limited	Nipissing	Cobalt.
O'Brien, M. J., Limited	O'Brien	Cobalt.
do	Miller-Lake O'Brien	Gowganda.
Penn-Canadian Mines, Limited	Penn-Canadian	Cobalt.
Pittsburg Lorrain Syndicate	H.R. 105, or Currie	Silver Centre.
Reeve-Dobie Mines, Limited	Reeve-Dobie	Gowganda.
Right-of-Way Mines, Limited	Right of Way	Cobalt.
Temiskaming Mining Company, Limited	Temiskaming	Cobalt.
Trethewey Silver-Cobalt Mine, Limited	Trethewey	Cobalt.

Refining the Silver

Much the larger part of the ore raised from the silver mines of Ontario is now treated and refined in the Province. The silver mining industry at Cobalt has undergone a normal course of development since the opening of the mines in 1904. At the beginning the entire output, consisting mainly of high-grade ore and metallic slabs and nuggets, was sent to smelters in the United States; then, as the deposits were opened up and low-grade ore and milling rock began to be encountered, concentration methods were introduced. This was followed by the establishment of refineries in the Province itself, not at Cobalt, but in other parts of Ontario, where plants already in existence could be made use of, or where there was cheap electric power. At a number of the mines themselves, smelting and cyanidation processes were introduced for the production of merchantable bars; and custom concentration and reduction plants were erected. As at the Nipissing mine, specialized methods of treating both high grade and low grade ores were devised and installed, and lastly the introduction of the flotation process for the concentration

of low grade rock and ore gave value to dump piles and large quantities of material that were previously regarded as worthless. The substitution of hydraulically generated electrical power for the steam engine at an early date materially lessened the cost of mine and mill operations. The working of the Mining Tax Act gave the local municipalities a large share of the revenues derived from mines, and enabled a first-class system of automobile roads to be constructed connecting the mines with the railway at Cobalt, and from the outset the Government railway itself, running as it did to the very collars of the mine shafts, effectually averted all transportation difficulties.

The southern Ontario refineries under the encouragement afforded by the Metal Refining Bounty Act not only produced refined silver bars, but also cobalt and nickel oxide, subsequently extending the list of products to include cobalt sulphate, carbonate and hydroxide, nickel sulphate, metallic cobalt and nickel, and stellite, an alloy of cobalt, tungsten and chromium, useful for the making of high-speed tools. Quantities of arsenic are obtained, sold chiefly as white arsenic or arsenious acid, a smaller proportion being disposed of as crude. A little metallic arsenic is also produced. It can thus be seen how large a part in the industrial growth of the Province the silver mining industry has played and continues to play, for the mines are by no means exhausted, and will continue to produce silver for years to come.

The statistics exhibiting the operations of the silver-cobalt refineries of Ontario show that over and above the value of the silver refined, there were produced and marketed from the ores and concentrates treated during 1917 no less than $1,872,744 worth of by-products. This total is exclusive of stellite, of which only one component, cobalt, is derived from these ores.

The refineries in operation were those of the Coniagas Reduction Company, Limited, Thorold; Deloro Smelting and Refining Company, Limited, Deloro, and Metals Chemical, Limited, Welland. The number of workmen employed was 391, and the amount paid out as wages for labour $542,925. Of the material treated, 5,719 tons were ore and concentrates, and 2,245 tons residues. To refineries in the United States there were consignments from Cobalt amounting to 6,307 tons, from which 2,914,267 fine ounces of silver were recovered. These shipments were on the whole of considerably lower grade than those to the home refineries, averaging only 462 ounces of silver to the ton, as against 810 ounces. Much the larger quantity treated by U.S. plants was at the works of the American Smelting and Refining company, Denver, Col., and Perth Amboy, N.J. From 129 tons of gold ore and slag received from Porcupine the U.S. plants recovered 1,958 ounces of silver. Out of the total quantity of silver contained in the product of the Cobalt mines in 1917, namely, 19,401,893 ounces, 14,504,681 ounces were refined at the mines in Cobalt or in Ontario works, being about 75 per cent. of the whole.

OPERATION OF ONTARIO SILVER-COBALT REFINERIES, 1917.

Product.		Quantity.	Value.
			$
Ore, Concentrates and Residues treated	tons	7,964	....
Silver recovered	fine ounces	6,451,363	5,289,782
Arsenic, White, shipments	lbs.	4,588,793	586,096
Arsenic, Crude, shipments	"	580,777	17,957
Arsenic, Metallic, shipments	"	13,575	5,430
Cobalt Oxide, shipments	"	418,703	533,489
Cobalt Carbonate and Sulphate, shipments	"	52,485	13,211
Cobalt, Metallic, shipments	"	396,395	589,290
Nickel Oxide, shipments	"	23,748	6,533
Nickel Sulphate, shipments	"	335,794	26,437
Nickel, Metallic, shipments	"	225,480	91,923
Cobalt and Nickel Oxides, not separated, shipments	"	4,757	2,378
Total value of products		....	7,162,526

The plants in southern Ontario for refining silver and recovering by-products from the ores of the Cobalt camp may be enumerated as follows:—

REFINERS OF SILVER-COBALT ORES, 1917.

Name of Company.	Location of Works.	P.O. Address.
Deloro Smelting and Refining Co., Limited	Deloro	Deloro.
Coniagas Reduction Co., Limited	Thorold	St. Catharines.
Metals Chemical, Limited	Welland	Welland.

In Cobalt camp itself, the following mines produce bullion from their own ores: Nipissing, O'Brien and Buffalo, and the first-named also from purchased ores. There are several plants which concentrate ores purchased for the purpose, or act as custom concentrators. These are Cobalt Reduction Company, a subsidiary of the Mining Corporation of Canada, Dominion Reduction Company, and Northern Customs Concentrators, Limited. The first two of these works produce bullion, the last concentrates only. In these three plants there were treated during the year 207,127 tons of ore, of which 1,547 tons were high grade, and 205,580 tons low grade. From the high grade ores were obtained 3,716,612 ounces of silver in bullion form. Concentrates from the low grade ores amounted to 6,290 tons. Shipments of concentrates from the plants consisted of 6,410 tons, containing 4,563,442 ounces of silver, or 712 ounces per ton.

Besides the concentration works proper, a sampling plant has been carried on for a number of years by Messrs. Campbell and Deyell. The business of this firm is confined to ore-sampling (valuing), assaying, and the melting of silver metallics into base bullion. In none of these processes except the melting of metallics are any values extracted. In the sampling process the ore is usually received in 30-ton lots, is crushed in a ball mill, then passed through machines which extract samples, after which the bulk of the ore is bagged and returned to the owners.

The number of employees in the foregoing works was 229, to whom were paid wages amounting to $256,553.

CONCENTRATION AND SAMPLING PLANTS, COBALT, 1917.

Name of Company or Firm.	Location of Plant.	P.O. Address.
Cobalt Reduction Company, Limited	Cobalt	Cobalt.
Dominion Reduction Company, Limited	Cobalt	Cobalt.
Northern Customs Concentrators, Limited	Cobalt	Cobalt.
Campbell and Deyell, Limited	Cobalt	Cobalt.

Refining Bounties on Cobalt and Nickel

By the Metal Refining Bounty Act (R.S.O., 1914, chapter 23) a bounty of six cents per pound was provided on refined cobalt and nickel and the oxides of these metals produced in Ontario from Ontario ores, the bounty being calculated on the metallic contents. There was provision also for a bounty of one and a half cents per pound on refined copper or copper sulphate similarly produced, and on white arsenic made from mispickel one-half cent. per pound. The term of the Act was originally five years from April 20, 1907, but was subsequently extended for another five years from April 20, 1912. It expired in 1917, and was not re-enacted, and the bounties ceased to be payable on April 20, 1917. The Act fixed a maximum amount payable on cobalt and cobalt oxide of $30,000 per annum, and on nickel and nickel oxide of $60,000 per annum, and provided that should the production in any one year be greater than could be paid for by the maximum bounty at the rate specified in the Act, the rate should be correspondingly reduced. In 1916 the cobalt production was in excess, consequently the rate per pound of metallic contents was reduced to 3.9131 cents.

For the broken period from January 1, 1917, until the expiry of the Act on April 20 of the same year, the sum of $16,469.13 was earned by the refining companies, as follows:—

PAYMENTS UNDER METAL REFINING BOUNTY ACT, 1917

Company	Product lbs.	Metallic Contents lbs.		Bounty		Total Bounty
		Cobalt	Nickel	Cobalt	Nickel	
Deloro Smelting & Refining Co., Ltd.				$ c.	$ c.	$ c.
Cobalt Oxide	6,400	4,544	....	272 64	....	....
" Metal	20,240	18,225	....	1,093 50	....	....
Stellite	60,736	33,204	....	1,992 24	....	....
Metallic Nickel	29,510	....	29,067	....	1,744 02	5,102 40
Coniagas Reduction Co., Ltd.—						
Cobalt Oxide	29,573	21,219	....	1,273 11	....	....
" Metal	82,702	81,122	....	4,867 33	....	....
Nickel Oxide	5,495	....	3,825	....	229 47	6,369 91
Metals Chemical, Ltd.—						
Cobalt Oxide	51,706	37,461	....	2,247 67	....	....
" Sulphate	30,366	6,225	....	373 48	....	....
" Hydroxide	7,210	3,967	....	283 03	....	....
Nickel Oxide	7,926	....	5,292	....	317 53	....
" Sulphate	147,506	....	30,134	....	1,808 06	....
" Carbonate	466	....	201	....	12 05	4,996 82
Total	....	205,967	68,519	12,358 00	4,111 13	16,469 13

During the ten years the Metal Refining Bounty Act was in force a total of $170,140.95 was paid out in bounties, details of which are given in the statements which follow. The Act provides a bounty on the refined metals and oxides only. As regards the other compounds and alloys upon which bounty has been paid, it should be pointed out that in the process of refining the ore, the oxides of the metals are necessarily first produced, and are subjected to subsequent manipulation in the preparation of the secondary compounds. The bounty in all cases is calculated on the pure metallic contents only. Nothing has ever been claimed as bounty on copper or arsenic. Large quantities of arsenic were made during the continuance of the Bounty Act, but being a product of the Cobalt silver ores it was not eligible for bounty, which, under the terms of the Act, was payable on arsenic made from mispickel only.

It may fairly be said that the Act was successful in achieving the object aimed at, namely, the establishing of a refining industry in Ontario for the treatment of the Cobalt silver ores, not only for their silver contents, but also for the cobalt and nickel.

TOTAL BOUNTIES PAID UNDER METAL REFINING BOUNTY ACT.

Cobalt

Company	Oxide lbs.	Metal lbs.	Carbonate lbs.	Hydroxide lbs.	Sulphate lbs.	Stellite lbs.	Bounty $
Deloro Smelting and Refining Co., Ltd....	941,989	228,755	....	....	....	118,528	48,930 93
Coniagas Reduction Co., Ltd	1,488,560	224,883	....	....	....	....	67,174 99
Metals Chemical, Ltd..	234,036	....	5,723	5,966	84,454	....	9,577 60
Canadian Smelting and Refining Co., Ltd....	36,137	....	....	....	....	....	1,026 05
Standard Smelting and Refining Co., Ltd....	5,026	....	....	....	....	....	214 92
Dominion Refineries, Limited	1,550	....	....	....	....	....	62 59
Total............	2,707,298	453,638	5,723	5,966	84,454	118,528	126,987 08

Nickel

Company	Oxide lbs.	Metal lbs.	Sulphate lbs.	Carbonate lbs.	Bounty $
Deloro Smelting and Refining Co. Ltd...	140,754	69,763	....	....	8,166 96
Coniagas Reduction Co., Ltd............	690,782	....	....	....	27,539 01
Metals Chemical, Ltd	57,557	....	360,215	466	6,776 04
Canadian Smelting and Refining Co., Ltd.	16,156	....	....	....	681 84
Total............................	905,249	69,763	360,215	466	43,153 85

Summary of Bounties Paid

Company	Cobalt	Nickel	Total
	$	$	$
Deloro Smelting and Refining Co., Ltd	48,930 93	8,166 96	57,097 89
Coniagas Reduction Co., Ltd	67,174 99	27,539 01	94,714 01
Metals Chemical, Ltd	9,577 60	6,766 04	16,343 65
Canadian Smelting and Refining Co., Ltd	1,026 05	681 84	1,707 89
Standard Smelting and Refining Co., Ltd	214 92	....	214 92
Dominion Refineries, Limited	62 59	....	62 59
Total	126,987 08	43,153 85	170,140 95

The Cobalt Industry

The production of cobalt blue or smalt for use in the manufacture of fine pottery or chinaware, so far as Europe is concerned, originated in Saxony in the early part of the sixteenth century, and has remained in existence there until the present time, but in gradually lessening importance as the ore deposits, very similar to those of Cobalt, were worked out. For a number of years previous to the discoveries in Ontario, the chief source of cobalt ore was New Caledonia, an island owned by France off the eastern coast of Australia. When the mines at Cobalt began to be worked in 1904, the chief metal being silver, cobalt and other constituents were little considered. It soon became apparent, however, that the silver could not be won without at the same time raising large quantities of cobalt, nickel and arsenic, for which practically no market existed. Most of the ore being exported and refined in the United States in plants unprovided with means for the recovery of these substances, they were in the main simply wasted. On refineries for treating the ores being established here, however, they were forced to grapple with the problem of saving the cobalt, etc. This led to investigation of the technical problems involved, and presently the refining companies were in a position to place large quantities of cobalt oxide on the European market, where the principal demand existed. Notwithstanding the strenuous efforts that were made to maintain the high price at which the finished article was sold, say $2.50 per pound, the weight of Ontario competition brought it down by successive stages to 75 or 80 cents per pound. Competition from New Caledonian sources was eliminated, and the Ontario article has continued to dominate the market. So tenacious of established custom is trade that many of the European manufacturers and dealers in cobalt blue simply re-packed the oxide from Ontario in their own packages, marked them with their old labels and sold them as such to their customers to satisfy their demand for the identical article they had been in the habit of using.

The outbreak of the war put an end to the export trade to the continent of Europe, but considerable quantities continued to be sold in England. The growing scarcity of tonnage led to the system of importations being permitted only under license, and also to the prohibition of re-exports from Britain. Previously the far Eastern demand for cobalt oxide had been supplied from London, but now, owing to the conditions brought about by the war, Ontario oxide is transported across the continent by rail and shipped from Seattle or Vancouver to Japan and China. The

demand in the United States and Canada for metallic cobalt has to a large and growing extent taken the place of the former demand for the oxide as a pigment in the ceramic trade. The alloy stellite, composed of cobalt, tungsten and chromium, has been found very useful for the manufacture of high-speed tools for working steel, and is largely used for this purpose by the makers of shells and other war munitions. Although cobalt and nickel are by nature more closely allied than perhaps any other two metals, their effects upon steel seem to be quite different. The addition of cobalt makes steel very hard, a quality necessary for machining tools, such as are used in turning-lathes, planers, etc. On the other hand, nickel makes steel tough, but not hard, hence its usefulness lies in quite other directions, such as increasing the resistance to torsion or strain of any kind. This property has led to an increasing employment of cobalt in the manufacture of special tool steels, intended to be used at high speed, and the greater part of the cobalt required for this use is supplied by the Ontario silver ore refining companies. Cobalt oxide now sells at $1.50 per pound and metallic cobalt at $2.50 per pound. The oxide is converted into metal in the electric furnace. Stocks of cobalt on hand at the refineries are not necessarily at the option of the refiners, since they cannot purchase silver ore or concentrates without taking also the cobalt which these contain. The new uses of which mention has been made have acted as an outlet for much cobalt which in some form or other would otherwise have accumulated at the works. Nevertheless, when peace returns, if trade resumes its wonted channels, there will be cobalt oxide of Ontario origin for all necessary uses so long as the silver mines remain in production, and perhaps longer.

The production of cobalt in metal, compounds and alloys for 1917 was as follows:—

	Produced, lbs.	Shipped, lbs.
Cobalt Oxide	802,448	418,703
Cobalt Metal	393,773	315,327
Cobalt in Stellite	......	81,068
Cobalt Sulphate and Carbonate	52,485	52,485
Cobalt and Nickel Oxides, not separated	......	4,757

There is published as Part III of this report, "Cobalt: Its Uses, Alloys, and Metallurgy," by C. W. Drury, Associate Professor of Metallurgy at Queen's University, Kingston, to which reference should be made for full information on the subject. Mr. Drury has obtained a variety of interesting and useful results by experimenting with a number of new alloys of the metal.

Copper

There is a good deal of non-nickeliferous copper ore in Ontario, on the north shore of Lake Huron, at various points west of Lake Superior, and also in the northern and eastern portions of the Province, but, so far, attempts at mining it have not met with large success. Bruce Mines has shown that these sulphide bodies occur in workable dimensions, and it is probable that if better conditions existed with regard to realizing the value of the ores, there would be a considerable production of copper from this source. As it is, copper mining is much hampered by the lack of local reduction works. All ores or concentrates must be shipped to Trail, B.C., or to points in the Eastern States, and the charges for freight and smelter treatment leave little margin, even at the present high price of copper, except in

the case of very rich ore. The Kenyon Copper Company, at Massey, is in a position to treat by flotation 100 tons of ore daily, producing therefrom concentrates containing from 20 to 25 per cent. copper, but operations are not remunerative at the price of copper fixed by the U.S. Government in September, 1917, namely, 23½ cents per pound. The recent revision of this price to 26 cents per pound will afford a somewhat better opportunity.

From the recently opened deposits near Mine Centre shipments were made by H. H. Wood. The Port Arthur Copper Company, which operated and shipped in 1916 under the name of the Mine Centre Copper Company, did considerable development work. The total shipments of ore and concentrates amounted to 4,173 tons, containing 431,402 pounds of copper. In addition, there was a recovery by U.S. refineries of 106,106 pounds of copper from silver ore and concentrates received from Cobalt silver mines, and 2,032 pounds from Porcupine gold slags. The whole production was, therefore, 539,540 pounds, or, say, 270 tons of copper. The Ontario refineries treating the ores and concentrates from Cobalt recognize the presence of a small percentage of copper varying from .4 to 1.24 per cent., but no effort is made to recover it except in one plant, where the by-product is being stocked in an unfinished condition.

Following is a list of the producers of purely copper ores in 1917:—

COPPER ORE PRODUCERS, 1917.

Name of Operator.	Name of Mine.	Location.	P.O. Address of Manager, etc.
Errington, Jos.		Gogama, C.N.Ry.	San Francisco.
Hudson Copper Co., Ltd.		Havilah	Havilah.
*Kenyon Copper Mines, Ltd.	Massey	Sault Branch, C.P. Ry.	Massey.
Ray. S. W.	Tip-Top	Kashabowie	Port Arthur.
Sudbury Copper Co.		Iron Bridge	Toronto.
Wood, H. H.		Mine Centre	Toronto.

*Formerly known as the Sable River Copper Company.

The chief source of the copper production of the province is the nickel-copper ore of the Sudbury area, where the smelters last year turned out 78,897 tons of matte, the copper contents of which were 21,197 tons. This was a decrease of 1,233 tons as compared with 1916, when the smelter product was 80,010 tons of matte containing 22,430 tons of copper. The average copper contents of the matte in 1916 were 28 per cent., and in 1917, 26.8 per cent. Further details regarding the Sudbury nickel-copper industry will be found under the heading of Nickel.

Nickel

The business of mining and smelting the nickel-copper ore of the Sudbury region has grown to large dimensions, as a few statistics will show. Last year 3,356 employees were employed in the mines and works, 1,854 underground, and 1,502 on the surface, to whom were paid wages amounting to $5,570,587. The mines were worked uninterruptedly. For roasting in heaps in the open air, to which process most of the ore is still subjected, some 28,846 cords of wood were required, having a value

of $115,250. To smelt the ore in the blast furnaces and converters 182,091 tons of coke were used, worth $2,187,353. In all, 1,506,828 tons of ore were raised from the mines, and 1,453,661 tons were smelted. The Bessemer matte product was 78,897 tons, the estimated contents of which were 41,887 tons of nickel and 21,197 tons of copper. The average composition of the whole of the matte product was thus 53.09 per cent. of nickel and 26.86 per cent. of copper, being a little higher in nickel and lower in copper than the matte of 1916, when the figures were 51.6 per cent. of nickel and 28 per cent. of copper.

The matte produced by the two smelting companies is quite dissimilar in the proportions of these metals. In 1917 the average contents of the Canadian Copper Company's matte were nickel 56.27 per cent., and copper 23.04 per cent., while the product of the Mond Nickel Company carried 39.57 per cent. of nickel and 43.10 per cent. of copper. This variation of composition reflects the difference in the nature of the ores smelted by the respective companies.

Ore production by the Canadian Copper Company was as follows:—

	Tons.
Creighton mine	1,003,814
Crean Hill mine	113,908
No. 2 mine	1,907
Total	1,139,629

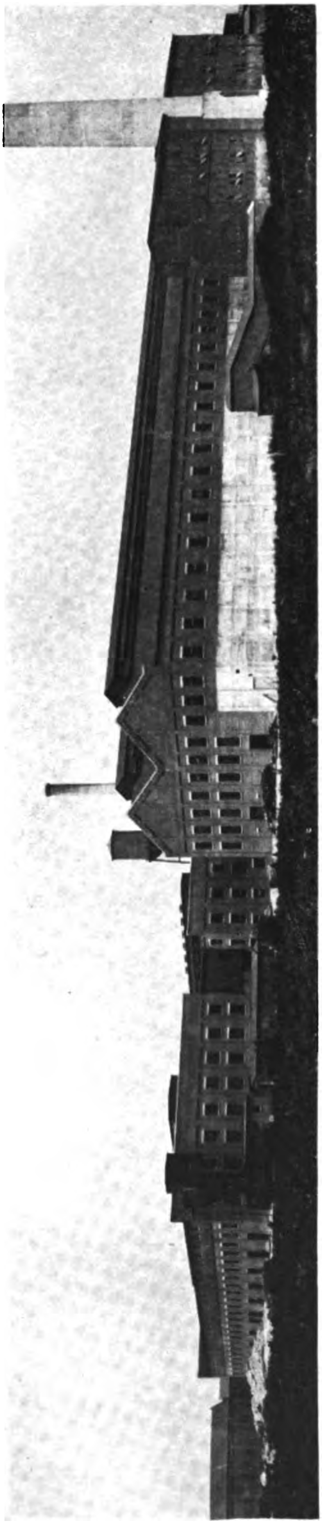
By the Mond Nickel Company:—

	Tons.
Garson mine	116,968
Victoria No. 1 mine	45 972
Worthington mine	75,012
Levack mine	88,587
Bruce mine	34,796
Total	361,335

The Alexo Mining Company raised 5,864 tons of nickel-copper ore from the mine of that name in the township of Dundonald, on the Porcupine branch of the Timiskaming and Northern Ontario railway, all of which was shipped to the Mond Company's works, at Coniston, to be smelted.

One of the most important of recent developments in the nickel industry is the establishment by the International Nickel Company of Canada, Limited, of a large refining plant at Port Colborne, Ont. It had for years been matter for regret that while Ontario was the greatest source of this important metal, it was entirely exported after having been smelted into matte, and the final separation of the nickel and copper was carried on elsewhere. It was shown beyond doubt by the Report of the Royal Ontario Nickel Commission[1] that nickel could be refined in Ontario, and that, so far from the long-maintained contention to the contrary being true, any one of the processes in existence was quite capable of being successfully operated here. Neither climatic conditions, want of skilled labour or chemicals, nor the cost of assembling the fuel, acids and other necessaries for the process, when put to the test proved to be an insuperable difficulty, and the Port Colborne refinery is now in operation. The process employed is the Orford one with variations, and the capacity of the works is 10,000 tons of nickel per annum, with a relative quantity of copper. A description of the plant is given elsewhere in this Report.

[1] A. T. Wilgress, Printer to the King's Most Excellent Majesty, Toronto, 1917.



Blast Furnace, Roasting Buildings and Cottrell Plant.

Administration Group of Buildings.

The two illustrations show the new Port Colborne plant of the International Nickel Company of Canada, Limited July, 1918.

It was expected that the British America Nickel Corporation, Limited, which is developing the large nickel-copper ore body known as the Murray mine, near Sudbury, would have followed suit by the erection of a refinery near the mine. The difficulty of procuring the necessary quantity of electrical power in the locality, however, proved too great to be overcome, and after considerable search the company decided to erect the refining works on the Quebec side of the Ottawa river near Hull, where sufficient energy could be obtained from that river, and ground has now been broken for the necessary buildings. The smelting plant is being constructed at the mine.

Table VIII. summarizes the course of the nickel-copper mining industry during the five years ending 1917. It will be seen that the tonnage of ore raised in 1917 was twice as great as that in 1913, the quantity smelted 76 per cent. more, the matte produced was 70 per cent. more, and the nickel and copper contents greater respectively by 68 and 63 per cent. The value of the nickel increased by 15¾ millions of dollars, and of the copper by upwards of 6 millions of dollars; these increases, however, are in part due to the higher prices adopted for computation. It is noteworthy that while the actual number of workmen was 156 smaller in 1917 than in 1913, the wages paid were 2¼ millions of dollars more. That is to say, the average earnings of the employees rose from $937 each in 1913 to $1,659 each in 1917, an increase of 77 per cent.

TABLE VIII.—NICKEL-COPPER MINING AND SMELTING, 1913-1917.

Schedule.	1913	1914	1915	1916	1917
Ore raised................tons.	784,697	1,000,364	1,339,322	1,572,804	1,536,828
Ore smelted.............. "	823,403	947,053	1,272,283	1,546,215	1,453,661
Bessemer matte produced.. "	47,150	46,396	67,703	80,010	78,897
Nickel contents of matte .. "	24,838	22,759	34,039	41,299	41,887
Copper contents of matte... "	12,938	14,448	19,608	22,430	21,197
Value of Nickel in matte.... $	5,237,477	5,108,997	17,019,500	20,649,279	20,943,500
Value of Copper in matte... $	1,839,438	2,080,034	3,921,600	8,299,051	7,842,890
Wages paid................ $	3,291,956	3,131,520	3,581,639	4,920,720	5,570,587
Men employed	3,512	3,464	4,178	4,730	3,356

The companies engaged in nickel-copper mining in 1917 were as follows:—

NICKEL-COPPER PRODUCERS, 1917.

Name of Company.	Name of Mine.	P.O. Address.
Canadian Copper Company	Creighton, Crean Hill, etc.	Copper Cliff.
Mond Nickel Company, Limited	Garson, Levack, etc...	Coniston.
The Alexo Mining Co., Ltd.	Alexo	Porquis Junction.

From the silver ores of the Cobalt mines there were produced in the Ontario refineries 225,480 pounds of metallic nickel, mostly in the form of shot, of about 98 per cent. purity. This is sold to manufacturers of platers' supplies and made into anodes. A market for metallic nickel has also been found in Italy, where it

is used in the structure of airplanes. The present capacity of the silver ore refineries for the production of metallic nickel is about 400 tons per annum. There are considerable stocks of nickel-bearing residues and nickel oxide at present on hand. Nickel sulphate is also being produced, a large use for which is in the hardening of oils and fats. A considerable quantity of nickel oxide was made during the year, as this form is the one in which the nickel is recovered from the ore, but only a small portion was marketed as oxide, most of it being converted into metallic nickel or nickel sulphate and sold as such. Some 4,757 pounds of unseparated oxides of nickel and cobalt were also sold, the value being $2,378.

Iron Ore and Pig Iron

Of the 176,833 tons of iron ore marketed in 1917, there were 136,343 tons exported to the United States. The balance went to Ontario blast furnaces. There were three producers: Moose Mountain, Ltd., also the Magpie and Helen mines of the Algoma Steel Corporation, Ltd. The last-mentioned shipped to the Magpie, where the ores from the two mines were mixed and treated in the roasting furnaces to produce a Bessemer grade of ore. Shipments from Moose Mountain were in the form of concentrates and briquettes. The number of men employed in the mines was 475, and the wages paid them amounted to $493,078.

Blast furnaces at Sault Ste. Marie (3), Hamilton (2), Port Colborne (1), and Deseronto (1) smelted 94,318 tons of Ontario ore and 1,221,881 tons of imported ore, producing therefrom 691,233 tons of pig iron valued at $14,201,695. It may be noted that only 7.16 per cent. of the value of the pig iron output can be credited to domestic ore.

Business was exceedingly brisk in the making of pig iron last year. The insistent demands of the war called for more and more iron, more and more steel, and the ordinary industrial requirements were for the time being obliged to accept scant consideration. This was also the condition in the United States, and in both countries the industry was strictly controlled. The two leading companies produced 862,504 tons of steel, consuming for the purpose a much larger quantity of pig iron than they made themselves. The total product of pig iron was 7,969 tons less than in 1916. The price of pig iron rose nearly 50 per cent.. the average valuation for 1916 being 13.94 per ton, while in 1917 it was $20.54. Steel was returned in 1916 at an average valuation of $18.70 per ton; last year the figures were $25.13 per ton.

Electro-Metals, Limited, Welland, produced a large tonnage of ferro-silicon. using quartzite, ganister rock, and pyrites cinder.

The undermentioned companies operated blast furnaces in 1917:

IRON BLAST FURNACES IN OPERATION, 1917.

Name of Company.	No. of Furnaces operated	Fuel used.	Location.
Algoma Steel Corporation. Limited.....	3	Coke	Sault Ste. Marie.
Canadian Furnace Company. Limited...	1	Coke	Port Colborne.
Standard Iron Company. Limited	1	Charcoal and Coke	Deseronto.
Steel Company of Canada. Limited.....	2	Coke	Hamilton.

Table IX gives particulars of the iron and steel-making industry of the Province for the last five years.

TABLE IX.—PRODUCTION IRON AND STEEL, 1913 TO 1917.

Schedule.	1913	1914	1915	1916	1917
Ontario ore smelted ....tons	132,708	163,779	293,305	215,366	94,318
Foreign ore smelted .... "	1,095,561	752,560	623,094	1,056,810	1,221,881
Limestone for flux .... "	351,741	252,258	215,686	296,988	319,535
Coke .... "	706,852	590,902	486,022	708,273	723,657
Charcoal ....bush.	2,206,191	920,045	1,314,957	1,843,209	1,288,390
Pig iron produced ....tons	648,899	556,112	493,400	699,202	691,233
Value of pig iron produced ...... $	8,719,892	7,041,079	5,910,625	9,739,704	14,201,695
Steel made ....tons	648,948	479,320	471,059	686,959	862,504
Value of steel made .... $	11,230,109	7,786,303	7,618,272	12,847,309	22,179,982

Molybdenite

The production of molybdenite concentrates in Ontario in 1917 was 77,517 pounds, an increase over 1916 of 52,955 pounds. The use of molybdenite in the manufacture of special tool steels, owing in part to the scarcity of tungsten, has led to a good deal of prospecting for deposits, and to the opening up and working of some of the most promising. Occurrences of molybdenite are apt to be pocketty and irregular, but are occasionally on a large scale, such as the mine now being worked at Quyon, Que. The alloy ferro-molybdenum, in which form the mineral is used by steelmakers, was made last year at Orillia and Belleville, the production being about 150,000 pounds.

Following is a list of the owners, with their addresses, from whose properties shipments of molybdenite were made:—

MOLYBDENITE SHIPPERS IN 1917.

Name.	Location of Deposit.	P.O. Address.
Armstrong, R. M.	Ashdod	Toronto, 13 Adelaide St.
Bourgault, M. A.	Calabogie	Ottawa, Marine Dept.
Canadian Molybdenite, Ltd.	Bagot township	Toronto, 801 Kent Bldg.
Foley, M. L.	Ross township	Toronto, 12 Maynard Ave.
Grey & Grey	Wilberforce	Toronto, 43 Imperial Life Bldg.
International Molybdenum Co., Ltd. ..	Mount St. Patrick ..	Renfrew.
Kelly, Mrs. W. R.	Tamworth	Tamworth.
McCoy, W. C.	Lyndoch township ...	Schutt.
Ontario Molybdenum Co., Ltd.	Tory Hill	Toronto, 305 Mail Bldg.
Opeongo Mining Syndicate	Opeongo	Renfrew.
Padwell, George	Monmouth township	Wilberforce.
Renfrew Molybdenum Mines, Ltd.	Brougham township ..	Montreal, Que, 402 Southam Bldg.
Spain, William J.	Dacre	New York, 417 Fifth Avenue.
Taylor, A. W.	Bagot township	Toronto, 123 Bay Street.

W. E. Joiner, of Moline, Ill., is engaged in developing molybdenite showings in the township of Cardiff, district of Haliburton, near Wilberforce station, on the Irondale, Ottawa, and Bancroft railway. One of these, owned by the Paudash Lake Molybdenite Mines, Limited, is on lot 18 in the ninth concession, where

the mineral occurs in large crystals. The other, known as the Joiner property, is on the north half of lot 3 in the twentieth concession. Frank C. Loring, M.E., states that the mineralized area on the latter has a northerly and southerly extent of about 1,500 feet and an easterly and westerly width of 150 to 400 feet, the ridge on which it occurs rising 100 to 150 feet above the low ground adjoining. A number of pits and trenches opened on the ridge and westerly slope have exposed molybdenite. In Mr. Loring's opinion the indications are promising for the presence of a large quantity of the mineral. Mr. Joiner proposes to further test the property by a number of open cuts across the ridge easterly and westerly from rim to rim, by blasting off the face of the bluff, and by diamond drilling.

Concentrating plants in operation were as follows:—

MOLYBDENITE CONCENTRATORS, 1917.

Concentrator.	Tons ore treated.	Lbs. concentrates produced.
International Molybdenum Company, Limited, Renfrew.	419.5	11,578
Mines Branch, Mines Department, Ottawa	250.8	6,521
Renfrew Molybdenum Mines, Limited, Mt. St. Patrick..	3,656.5	57,254
Total....................................	4,326.8	75,353

In electric furnaces at Orillia and Belleville, ferro-molybdenum was produced as follows:—

FERRO-MOLYBDENUM PRODUCERS, 1917.

Refinery.	Location	Ferro-Molybdenum lbs.
International Molybdenum Co., Limited................	Orillia	81,000
Tivani Electric Steel Co	Belleville........	69,000
Total		150,000

The value of the ferro-molybdenum product was $349,355.

A comprehensive account of molybdenite in Ontario was contained in a report by Arthur L. Parsons, published in the twenty-sixth annual volume of the Bureau, 1917.

Lead

The production of ore last year amounted to 16,602 tons, compared with 6,481 tons in 1916. The output was almost wholly from the mine at Galetta, in Carleton County, owned by the James Robertson Estate, Montreal. A few tons were raised by the North Victoria Mines, Limited, from a property near Kinmount, in the district of Haliburton, and a small quantity of concentrates from the old Frontenac lead mine were smelted by the Kingston Smelting Company, Limited, although the mine itself was not worked. The Galetta smelter and that of the Kingston Smelting Company turned out a total of 4,228,512 pounds of pig lead,

valued at $316,534, of which 1,772,512 pounds, worth $172,601, were from Ontario ore, and 2,456,000 pounds, worth $243,933, from ore imported from outside points.

The number of mine employees was 74 and of smelter hands 47, total 121. Wages paid, mines $54,029, smelters $31,499, total $85,528.

LEAD ORE PRODUCERS, 1917.

Name of Company.	Location of Mine.	P.O. Address.
Estate of James Robertson	Galetta	Montreal.
North Victoria Lead Mines, Limited	Kinmount	Toronto.

LEAD ORE SMELTERS, 1917.

Name of Company.	Location of Smelter.	Address.
Estate of James Robertson	Galetta	Montreal.
Kingston Smelting Company, Limited	Kingston	Kingston.

Materials of Construction

Clay Products

The clay industry in war time may be regarded as more or less non-essential. In the United States the Fuel Administration has taken this view, hence orders have been issued curtailing the output of clay products for 1918 from 15 to 50 per cent., and placing the entire manufacturing programme on a war basis. In Ontario many brick and tile plants were idle throughout the year 1917.

Though the value of clay products has risen considerably during 1917 owing to high operating costs, the output also shows a small increase as compared with 1916. This does not appear to be the case with tile and hollow ware as far as quantity is concerned, but it may be pointed out that such products should be reported on a tonnage rather than a numerical basis, because of the wide range both in size and shape of drain and building tile. Building permits in Toronto in 1917 exceeded in number those of 1916 by 12 per cent., but the total value of the buildings was 28 per cent. less.

Pressed and Fancy Brick.—The output of pressed and fancy brick in 1917 was 36,233 M, worth $474,614, as compared with 31,742 M, worth $318,942, in 1916. Of this production the Milton Pressed Brick Company contributed over one half. Wages amounting to $206,844 were paid to 407 employees.

Common Brick, Drain and Building Tile.—Apart from two large makers of building tile, hollow clay blocks are produced only to a limited extent, and chiefly in localities where gravel is scarce. They are used for barn foundations and for other buildings such as chicken and pig pens, milk houses, garages, etc., since they

afford a dry, warm wall that can be cheaply erected. Sizes vary: 4 by 4 by 12; 4 by 8 by 12 and 6 by 10 by 12 inches being common. Smaller sizes are used for interior walls in houses. The large makers in Ontario are the National Fireproofing Company of Canada, Limited, and the Sun Brick Company.

The average period of operation for the brick and tile plants was 131 days in the year 1917. Many of the smaller plants operate in the summer months only. Employees numbered 909, and $473,375 was paid in wages.

As fuel and labour costs continue to advance, the cost of manufacturing clay products increases. In 1917 for common brick, also drain and building tile, the following figures show the output, value, fuel consumption, and cost:—

OUTPUT AND VALUE OF BRICK AND TILE, 1917.

Product	M.	Value $	Value per M.
Common Brick	68,214	713,824	$10 46
Drain Tile	15,940	546,040	....
Hollow Building Tile	3,933	301,688	....

FUEL CONSUMPTION.

Wood			Coal or Coke			Natural Gas		
Cords	Value $		Tons	Value $		M. cu. ft.	Value $	
	Total	per cord		Total	per ton		Total	per M.
17,289	74,258	4 29	19,856	150,802	7 59	157,180	24,712	0 16

Following is a list of the brick and tile operators who reported an output in 1917:—

BRICK AND TILE PLANTS.

Name.	Address.	Product.
Alvinston Brick & Tile Co., Ltd.	Alvinston	Brick, Tile and Hollow Blocks.
Armstrong Bros	Fletcher	Tile.
Attercliffe Standard Brick, Block & Tile Co.	Attercliffe	Tile.
Arnott, Thos. H.	Bracebridge	Brick.
Baird & Son, H. C.	Parkhill	Brick and Tile.
Baker, Geo. E.	Arnprior	Hollow Blocks.
Baker Bros.	Casselman	Brick.
Bell Bros.	Paisley	Brick.
Bogart Bros.	Southwold	Tile.
Bond & Bird	Woodstock, R.R. No. 5	Brick.
Brampton Pressed Brick Co., Ltd.	Brampton	Pressed Brick.
Broadwell & Son, B.	Kingsville	Tile.
Brown, J. W.	Vienna	Tile.
Brownscombe, H.	Cargill	Brick and Tile.
Brownscombe Bros.	Paisley, R.R. No. 2	Brick and Tile.
Buck, J. L.	Port Rowan	Brick and Tile.
Butwell, Henry	Toronto	Brick.

BRICK AND TILE PLANTS.—*Continued.*

Name.	Address.	Product.
Cabana, Jr., Oliver	Zurich	Brick and Tile
Cairo Brick and Tile Works	Cairo	Brick and Tile
Campbell, Neil F.	West Lorne	Tile.
Canada Sand-Lime Pressed Brick Co., Ltd.	West Toronto	Sand-Lime Brick.
Canadian Pressed Brick Co., Ltd.	Hamilton	Pressed Brick.
Clark, Walter	Corunna	Brick and Tile.
Cooper, W. H.	Hamilton	Brick.
Curtin, Frank	Lindsay	Brick.
Curtis Bros.	Peterboro', R.R. No. 9	Brick and Tile.
Deller & Sons, Geo.	Norwich	Brick, Tile and Hollow Blocks.
Deller, Wm. H.	Thorndale, R.R. No. 4	Tile.
Dochart Brick & Tile Works	Arnprior	Brick, Tile and Blocks.
Dolan, John	Watford, R.R. No. 2	Tile.
Dominion Sewer Pipe Co., Ltd.	Aldershot	Brick and Tile.
Don Valley Brick Works	Todmorden	Common, Pressed and Fancy Brick.
Elliott, Chas.	Bluevale	Brick and Tile.
Elliott & Sons, Jas.	Steelton	Brick.
Fox, G. J.	Dresden	Brick.
Frank, E. D.	Strathroy, R.R. No. 6	Brick and Tile.
Frid Bros.	Hamilton	Brick.
Frost, Geo. H.	Toronto	Brick.
Gardiner, William	Blenheim	Brick and Tile.
Govenlock, J. M.	Seaforth, R.R. No. 1	Tile.
Hallatt, H.	Comber	Brick and Tile.
Halton Brick Co., Ltd.	Terra Cotta	Pressed Brick.
Hamilton Pressed Brick Co., Limited	Hamilton	Pressed Brick.
Hepworth Silica Pressed Brick Co., Ltd.	Hepworth	Pressed Brick.
Hill Brick Co.	Madoc	Brick.
Hill, A. W.	Coatsworth, R.R. No. 1	Brick and Tile.
Hinde Bros.	West Toronto	Brick.
Hiscock & Sons	Cobourg	Brick.
Hitch, Mrs. Susan	Ridgetown	Brick, Tile and Hollow Blocks.
Hitch, Thos.	St. Thomas	Brick and Tile.
Hohl, John	Wellesley, R.R. No. 1	Brick and Tile.
Holland & Son, William	Ruscomb	Tile.
Holton, R. J.	Clifford, R.R. No. 3	Tile.
Howlett, Fred.	Petrolia	Tile.
Interprovincial Brick Co. of Canada, Ltd.	Cheltenham	Pressed Brick.
Janes, D. A.	Delaware	Brick and Tile.
Jasperson, B.	Kingsville	Brick, Tile and Hollow Blocks.
Jervis & Son, John	Dorchester Station	Brick and Tile.
Jordan, D.	Chatham	Brick and Tile.
Kaar, John	Brownsville	Brick and Tile.
Koebel, Joseph Z.	St. Clements	Brick and Tile.
Kruse Bros.	Egmondville	Brick and Tile.
Kuhn, Henry J.	Crediton	Tile.
Labey & Son, Geo. A.	Foxboro'	Tile.
Leamington Brick & Tile Co., Ltd.	Leamington	Brick and Tile.
Lindsay, Stephen	Wallaceburg, R.R. No. 2	Tile.
Logan Brick Works	Toronto	Brick.
Lowe, Jos.	Meaford, R.R. No. 1	Tile.
Lowes, Gordon	Kent Centre	Brick and Tile.

BRICK AND TILE PLANTS.—*Continued.*

Name.	Address.	Product.
MacKay Bros.	Dutton	Brick and Tile.
McCredie & Reid	Belmont, R.R. No. 3	Brick and Tile.
McGibbon, Dugald	Shedden	Tile.
McLoughlin, John	London	Brick.
Marshall, W. W.	Woodstock	Brick and Tile.
Martin, David	Thamesville	Brick and Tile.
Middleton, Chas.	Wyoming	Tile.
Milton Pressed Brick Co., Ltd.	Milton	Pressed and Fancy Brick.
Miner, J. T.	Kingsville, R.R. No. 2	Brick and Tile.
Napanee Brick & Tile Co., Limited	Napanee	Brick and Tile.
National Fire Proofing Co. of Canada, Ltd	Aldershot	Hollow Blocks.
Naylor & Sons, J. W.	Trenton	Brick.
New, Edward	Hamilton	Brick.
Norton, Alsey	Bolton	Tile.
Odell & Sons, Wm.	Ingersoll	Brick, Tile and Blocks.
Ollman Bros.	Hamilton	Brick,
Ontario Paving Brick Co., Limited	West Toronto	Brick.
Ott Brick & Tile Mfg. Co., Limited	Kitchener	Brick.
Ottawa Brick Mfg. Co., Limited, The	Ottawa	Brick.
Owen Sound Brick Co., Limited	Owen Sound	Brick.
Parks, H. W.	Dresden	Tile and Hollow Blocks.
Paxton & Bray	St. Catharines	Brick.
Pears & Son, James	Toronto	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Petty, Chas.	Cherrywood	Tile.
Phillips & Son, Thos.	Lucknow, R.R. No. 1	Tile.
Phinn, Geo. E.	Lucan	Brick, Tile and Hollow Blocks.
Port Credit Brick Co., Limited, The	Port Credit	Common and Pressed Brick.
Price Estate, John	Toronto	Brick.
Provincial Secretary's Department	Mimico	Drain, Floor and Building Tile; Brick.
Richardson & Son, James	Kerwood	Brick and Tile.
Ries, John	Carlsruhe	Brick and Tile.
Russell, Joseph	Toronto	Brick.
Sadler, F. L.	Dublin	Brick and Tile.
Silicate Brick Co. of Ottawa, Ltd.	Ottawa	Sand-Lime Brick.
Sipprell, J. H.	Wilkesport	Tile.
Smith & Son, Alex.	Dutton, R.R. No. 2	Brick and Tile.
Snelgrove & Teer	Beaverton	Brick and Tile.
Stickwood, Chas.	Newmarket	Brick.
Sudbury Brick Co., Limited	Sudbury	Brick.
Sun Brick Co., Limited	Toronto	Fancy Brick and Hollow Blocks.
Thompson Bros.	Essex	Brick and Tile.
Thornton, John	Perth	Brick.
Toronto Brick Co., Limited	Toronto	Sand-Lime Brick.
Wagstaff, Chas.	Lindsay	Brick and Tile.
Waite, J. E.	Forrester's Falls	Brick and Tile.
Wallace & Son, R.	North Bay	Brick.
Wallaceburg Brick Co.	Wallaceburg	Brick.
Warwick Brick Works	London	Brick.
Watson Brick Co.	Bracebridge	Brick and Tile.
Wood, W. H.	Brockville	Brick.
Wright, J. C.	Proton	Brick and Tile.
Yaeck, Louis	Walkerton	Brick and Tile.
York Sandstone Brick Co., Limited	East Toronto	Sand-Lime Brick.

Pottery.—No high-grade pottery is manufactured in Ontario, the glacial clays not being suited for the purpose. The value of pottery made in 1917, as reported by the producers mentioned below, was $94,501. Wages paid 41 employees amounted to $35,318.

The following is a list of operators in 1917:—

POTTERY PRODUCERS, 1917.

Name.	Address.
R. Campbell's Sons	Lock St. South, Hamilton.
J. Cranston Estate	216 Dundurn St. South, Hamilton.
Davis, Joseph S.	1967 Yonge St., Toronto.
Foster Pottery Company	Main St. West, Hamilton.
Taylor, Geo. M.	Port Hope.

Sewer Pipe.—There are three companies making sewer pipe in Ontario. Raw material suitable for sewer pipe purposes is not widely distributed. It is a plastic Medina shale free from lime, and the entire quantity comes from the vicinity of Waterdown, near Hamilton. Sewer pipe manufacture involves careful manipulation in order to secure a high percentage of perfectly vitrified, salt-glazed and unwarped pipe.

Sewer pipe marketed in 1917 was worth $378,923. The wages paid 202 men employed in the industry amounted to $168,421.

Following is a list of the companies:—

SEWER PIPE WORKS, 1917.

Name of Company.	Location of Plant.	P.O. Address of Manager, etc.
Dominion Sewer Pipe Co., Ltd.	Swansea	Swansea.
Hamilton & Toronto Sewer Pipe Co., Ltd.	Hamilton	Hamilton.
Ontario Sewer Pipe Co., Ltd.	Mimico	Mimico.

Brick, Tile, Sewer Pipe and Pottery

The following table shows the comparative value of the output of clay products since the outbreak of war:—

Year.	Brick.		Pottery.	Drain Tile.	Sewer Pipe.	Total.
	Common.	Pressed, Fancy, Terra Cotta, etc.				
	$	$	$	$	$	$
1914	2,336,207	894,384	25,720	277,530	571,756	4,105,597
1915	763,591	375,865	49,387	321,253	361,283	1,871,379
1916	509,559	495,895	87,025	275,471	216,749	1,584,699
1917	713,824	776,302	94,501	546,040	379,923	2,509,590

Refractory Clay from Mattagami River

Hitherto clays have not been found in Ontario suitable for making chinaware or porcelain, and in consequence the pottery trade of the Province has not been able to advance beyond the coarsest kinds of ware, such as flower pots, jardinieres, etc., except by the use of imported clays.

A dissovery made by Capt. C. M. McCarthy, of Elk Lake, on the east bank of the Mattagami river, opposite an island at the foot of the Long Portage, has shown the existence there of a deposit of excellent white fire clay of highly refractory character, believed to be capable also of taking the place of English "ball" clay in the manufacture of porcelain. An examination of the clay was made by Prof. Geo. A. Guess, of the University of Toronto, in November, 1917, who reported that it was a good grade of ball clay, the following being a partial analysis:—

	Per cent.
Silica	52.7
Alumina	32.1
Iron	Trace
Lime	Trace

It had a very high plasticity, and an air shrinkage of 6.7 per cent. Burned to cone 5 (1,230° C.) it showed a shrinkage of 14.8 per cent. The colour on burning was almost white—a slight cream colour. The test pieces on burning cracked after the manner of undiluted ball clay.

A fuller analysis by W. K. McNeill, Provincial Assayer, gave the following composition:—

	Per cent.
Silica	53.10
Alumina	31.98
Ferric Oxide	1.52
Ferrous Oxide	Nil
Lime	0.51
Magnesia	Trace
Soda	0.54
Potash	0.28
Loss on ignition	12.35
Total	100.28

Samples were sent to the Canadian Porcelain Company, Limited, Hamilton, who undertook to give them a practical test. After doing so, the company reported as follows on 10th January, 1918:—

> We fired samples of the ball clay of Capt. C. M. McCarthy in our kilns and find that the same is practically as plastic as the English ball clay, but has a slightly greater shrinkage. We believe that the clay would be satisfactory for use in porcelain bodies after proper allowance had been made for the variation in the shrinkage.

The clay was also tested at the Mines Department, Ottawa, J. Keele, chief ceramic engineer, reporting it to be a light grey to white clay when dry, and requiring 23 per cent. of water to bring it to the best working consistency. It had good plasticity and working qualities. Its drying qualities were good, and the shrink-

age of dried test pieces was 6 per cent. It burned to a porous but strong body of nearly white colour at the lower temperatures or up to 2,100° Fahr. When burned to temperatures higher than this the body became slightly denser and cream-coloured. When raised to temperature of cone 33 (3,254° Fahr.) the clay softened. Mr. Keele pronounced it a No. 1 fire clay, and one of the most refractory clays yet found in Canada. Its working, drying, and burning qualities were very satisfactory, so that it could be moulded into special shapes for refractory purposes.

In making pottery trials, the clay was thoroughly mixed with an excess of water and washed through a 200-mesh screen. The residue remaining on the screen was 20 per cent. of the original weight and consisted almost wholly of small quartz grains. The washed clay was dried, and a mixture was made consisting of 50 per cent. of the clay, 20 per cent. ground feldspar, and 30 per cent. ground quartz. This mixture was made into a slip and cast in the form of small cups. These were burned at a low temperature and four of them sent to the Mayer China Company, of Beaver Falls, Pa., where they were burned in the china biscuit kiln to cone 10, and glazed and re-fired in the china glost kiln at cone 4. The pieces turned out had a beautiful ivory tone, but were not suitable for china or semi-porcelain wares, for which a white colour is strictly required.

Mr. Keele adds that the clay could be used to advantage in making sanitary porcelain, vitrified floor tiles and wall tiles, or probably for electric porcelain. Much of the china clay imported for these purposes is not as good a colour as the Mattagami clay, and a little cobalt stain added to this clay would materially improve the colour.

A sample of red clay, found on the same property, proved on testing to be very plastic and smooth, being rather more plastic than the white clay. It burned to a red colour and hard, dense body at about 2,200° Fahr. It fused at cone 20 (2,786° Fahr.), so that it is not a fire clay, but only semi-refractory. A good fire brick could probably be made from a mixture of one part red clay with two parts of white clay, and a similar mixture could also be used for the manufacture of stoneware pottery.

In June, 1918, Capt. McCarthy reported he had pretty thoroughly investigated this deposit of clay by sinking pits, digging trenches, and putting down auger holes. He is convinced the clay occurs over the whole width of his claim of 40 chains, and that it is about 100 feet or over in depth. The red clay lies to the south of the white.

Lime

The output of lime last year as shown in Table II was 2,820,507 bushels, valued at $1,111,264, while that for 1916 was given as 1,453,254 bushels, worth $657,364. The large increase in production is explained by the fact that heretofore the lime made by large manufacturing concerns such as the American Cyanamid Company and the Dominion Sugar Company for use in their processes was not included in the statistics, since it did not come upon the market for sale as lime. It would seem, however, that for whatever purpose the lime is used, whether in manufacturing or treating other products, or for building, the figures ought properly to be

reckoned in the general total. The two companies mentioned produced in 1917 nearly 1,000,000 bushels. It will be noted that while the price in 1916 averaged 18.6 cents per bushel, in 1917 it rose to 23.3 cents. The making of lime tends more and more to fall into the hands of the large operators. The day of the small kiln worked by the farmer or his boys, spasmodically and to supply the needs of a very local and restricted market, has virtually passed. In this, as in every other manufacturing industry, proper organization, technical skill and sufficient capital are necessary. For fuel in burning, wood is still largely used, but more lime is now burned with coal than any other fuel. Coke is also employed, and a few makers use natural gas. The number of men employed was 325, and the wages paid $262,132.

Below are given the names of producers and the location of plants in Ontario which operated in 1917:—

LIME PRODUCERS, 1917.

Name of Owner or Company.	Location.
American Cyanamid Co.	Niagara Falls.
Beachville White Lime Co., Limited	Beachville.
Bergin, Patrick	Napanee.
Cameron, W. M.	Carleton Place.
Canada Lime Company, Limited	Coboconk.
Chalmers & Campbell	Owen Sound.
Chestnut, W. D.	Duntroon.
Christie, Henderson & Co., Limited	Puslinch, Kelso and Hespeler.
Contractors' Supply Co., Limited	Melville Junction and Teeswater.
Delta Lime Co., Limited	Delta.
Dominion Sugar Co., Limited	Wallaceburg, Chatham and Kitchener.
Elora White Lime Co., Limited	Elora.
Gallagher Lime & Stone Co., Limited	Hamilton.
Guest, Mrs. E. J.	Ancaster.
Harvey, E., Limited	Rockwood.
Higginson & Stevens	Hawkesbury.
Jamieson, J. M.	Forrester's Falls.
Jamieson Lime Co.	Renfrew.
McGilvray, James	Priceville, R.R. No. 2.
McTernan, John	Torbolton.
Marshall Lime & Cement Works, Jas.	Hamilton.
Parks Bros.	Troy.
Robertson Co., D., Limited	Milton.
Smith, John S.	Inverhuron.
Standard Chemical Iron & Lumber Co., Limited	Eganville.
Standard White Lime Co., Limited	Beachville, Guelph, and St. Marys.
Toronto Brick Company, Limited	Coboconk.
Toronto Lime Co., Limited	Limehouse and Dolly Varden.
Weppler, Henry	Priceville, R.R. No. 1.

Portland Cement

The quantity of cement made in Ontario factories and sold in 1917 shows a small decline as compared with 1916. Building construction was hampered through scarcity of labour, and hence the demand was less. Barrels of cement marketed in 1916 were 2,143,949, valued at $2,242,433, while the 1917 figures were 2,063,231

and $2,934,271, respectively. The average price per barrel, however, rose from $1.05 to $1.42. Cement on hand at the end of the year totalled 567,261 barrels.

The industry employed 589 men in 1917, and wages paid amounted to $538,355.

The following cement plants were operated:

PORTLAND CEMENT PLANTS, 1917.

Name of Company.	Location of Plant.	P.O. Address of Manager, etc.
Canada Cement Company, Limited, Plant No. 5 ..	Thurlow tp., near Belleville	Herald Bldg., Montreal, Que.
do do do No. 8 ..	near Port Colborne...	do do
The Hanover Portland Cement Co., Limited	Hanover	Hanover.
National Portland Cement Co., Limited	Durham	Durham.
The Ontario Portland Cement Co., Limited	Blue Lake	Brantford.
St. Marys Portland Cement Co., Limited	St. Marys	St. Marys.

The following works were not operated during the year: Canada Cement Company, Limited, Plant No. 4, Thurlow; No. 5, Hungerford; No. 7, Lakefield; No. 9, Shallow Lake; Union Cement Company and Imperial Cement Company, Owen Sound. The last-named company is defunct. The Maple Leaf Cement Company, Atwood, and the Kirkfield Portland Cement Company, Raven Lake, were also idle.

Cement Products

From the Portland cement made from clay and limestone or marl, cement brick, blocks, tile and sewer pipe are manufactured. The demand for tile is increasing, and in many localities cement tile are competing successfully with the clay product, particularly for large sizes. As sand, gravel and cement are recorded in the table of production it has not been thought advisable to include cement products in the total valuation of the mineral output of the Province.

Returns received show an output as follows for the year 1917:—

Product.	Number.	Value
Cement Brick	130,000	$1,420
Cement Blocks	48,661	8,312
Cement Tile and Sewer Pipe..............	2,412,787	90,586
Total	....	$100,318

The industry employed 105 men and $28,641 was paid in wages. The average time the producers operated was 105 days.

The following list gives the names and addresses of manufacturers of cement products reporting to the Bureau of Mines:—

MANUFACTURERS OF CEMENT PRODUCTS, 1917.

Name.	Address.	Product.
Andrews, S. J.	Clinton	Blocks and Tile.
Beuglas, Jas.	Bright, R.R. No. 3	Tile.
Brennan & Hollingworth	Hamilton	Tile.
Clark, W. H.	Gananoque, R.R. No. 3	Blocks.
Corlett, A. S.	Leamington	Brick.
Deline, L.	Enterprise	Blocks and Tile.
de Jersey, O. W.	Forest	Blocks.
Deveney & Campbell	St. Marys	Blocks and Tile.
Dillon, Jno.	Seeley's Bay	Tile
Fletcher & Sons, J. H.	Fonthill	Blocks.
Grece, G. C.	Wallaceburg	Blocks and Tile.
Hagerman, A. V.	Odessa	Tile.
Hay & Son, J. C.	Listowel	Tile.
Hoy, William J.	Prescott	Brick, Blocks and Tile.
Hyndman, Jno.	Gorrie	Tile.
Iler Concrete Tile Co.	Arner	Tile.
Karr & Rose	Petrolia	Tile.
Kilgour, D. G.	Eganville	Tile.
Kinzel & Son, Jos.	Preston	Blocks and Tile.
McLenaghan, W. A.	Essex	Blocks and Tile.
McQueen, Alex.	Arthur	Tile.
Malcolm, Jno.	Fergus.	Tile.
Markus, Wm., Ltd.	Pembroke	Blocks.
Mitchell, Frank	Pickering	Tile.
Moore, D. G.	Ailsa Craig	Blocks and Tile.
National Concrete Co.	Lindsay	Blocks and Tile.
Oil Springs Tile & Cement Co.	Oil Springs	Tile.
Ord, John A.	Guelph, R.R. No. 3	Tile.
Pfaff, W. E.	Hensall	Blocks and Tile.
Philp, Wm.	Port Perry, R.R. No. 4.	Tile.
Schmidt, J. T.	St. Jacobs	Brick, Blocks and Tile.
Schram, A. J.	Camlachie	Tile.
Smith, A. G. C.	Acton	Blocks and Tile.
Taylor & Hall	Peterboro	Blocks and Tile.
Webster Construction Co., Limited	London	Tile.
Williams, E. J.	Wheatley	Blocks and Tile.
Wyatt, W. J.	Cottam	Blocks and Tile.

Sand and Gravel

For making and repairing roads, for concrete work and building purposes generally, sand and gravel are annually raised in large quantities. Special varieties of sand, such as those used for moulding in foundries or for glass-making, are also in demand. The glacial action which in past ages determined the form and nature of the present surface of the Province resulted in the deposition of innumerable accumulations of detrital material, which is now found so useful in the economy of everyday life. In certain parts, such as counties in the extreme southwest part of the peninsula, sand and gravel are less abundant and dearer. With regard to the Province as a whole, the cost of sand and gravel largely depends upon the cost of labour and transportation. A considerable quantity of these materials is taken

from the beds of the great lakes and boundary rivers, much of which is exported to lake ports south of the line. Licenses authorizing such removal are issued by the Department of Lands, Forests and Mines on a royalty basis, the charges varying from three to twelve cents per cubic yard. From this source the receipts for the fiscal year ending October 31, 1917, were $28,372.93.

In view of the importance of sand and gravel, an investigation into these resources has been begun by the Bureau. Auguste Ledoux, Professor of Mineralogy in the University of Brussels, Belgium, is now carrying on this work, and the first instalment of the results of his labours is printed as Part II of this report under the title "Sands and Gravels Deposits of Southern Ontario." It is intended to continue the investigation next year and to include in it the deposits of the newer parts of the Province in so far as they are accessible to examination.

Returns have been received by the Bureau from 129 firms or individuals who operated sand or gravel pits or who dredged for these materials in 1917. Many operations of this kind were on a small scale and carried on only at intervals. Owing doubtless to the curtailment of operations on public works, the output of sand and gravel was somewhat less in 1917 than in 1916, the quantity raised being 1,187,973 cubic yards and the value $431,597, as against 1,265,973 cubic yards worth $470,963 in 1916. Following is a list of sand and gravel operators who removed 1,000 cubic yards or more during the year:—

SAND AND GRAVEL OPERATORS, 1917.

Name of Owner or Company.	Material.	Address.
Armstrong Supply Co., The, Limited	Gravel	Hamilton, 106, Dunsmere Ave.
*Ashton, Thos.	Sand	Toronto, 1354 Queen St. E.
*Barnes, William	Sand	Hamilton, 132 Blake St.
†Barton Sand & Gravel Co., The, Limited	Sand and Gravel	Bartonville.
Cadwell Dredging Co., Limited	Sand and Gravel	Windsor.
Cameron Steamship Co.	Gravel	Detroit, Mich.
Canadian Steel Corporation, Limited	Gravel	Ojibway.
Canadian Towing & Wrecking Co., Limited	Sand and Gravel	Port Arthur.
Chapman, Walter	Gravel	Uxbridge.
Chatham, Wallaceburg & Lake Erie Railway Co.	Gravel	Chatham.
Chippawa River Sand & Gravel Co.	Gravel	Chippawa.
Cleary & Annable	Gravel	Mille Roches.
Constructing & Paving Co. of Ontario, Limited	Sand and Gravel	Toronto, 708 Confed. Life Bldg.
Creeper, John	Sand and Gravel	Belleville, R.R. 5.
Crow, H. E.	Sand and Gravel	Chatham, 30 Emma St.
Empire Limestone Co.	Sand	Buffalo, N.Y., 19 Hudson St.
Empire Sand & Gravel Co., Limited	Sand	Weston.
Fonthill Gravel Co.	Sand	Thorold, P.O. Box 655.
*Gillespie, Thos. M.	Sand	Perth, P.O. Box 16.

* Moulding sand producers.
† Washing and screening plants.

SAND AND GRAVEL OPERATORS, 1917.—*Continued.*

Name of Owner or Company.	Material	Address.
Godson Contracting Co., Limited	Sand and Gravel	Toronto, 72 Queen St. E.
Goodale, Emerson	Sand and Gravel	Hamilton, 98 Aikman Ave.
Hamilton, J. C.	Sand	Pembroke.
†Hamilton Sand & Gravel, Limited	Sand and Gravel	Hamilton, 37½ McNab St.
Hansen, H. C.	Sand and Gravel	Cleveland, O., 7325 Clinton Ave.
Hope Township, Municipality of	Sand and Gravel	Port Hope, R.R. 1.
Karr & Rose	Gravel	Petrolia.
Kelley Island Lime & Transport Co., Ltd.	Sand	Sandusky, Ohio.
Kerr, John, Estate of	Sand and Gravel	Petrolia.
Kingston Sand & Gravel Co.	Sand	Kingston, R.R. 5.
Lindsay, Corporation of	Sand	Lindsay.
Lyons Fuel & Supply Co., Limited	Gravel	Steelton.
McMurray, Geo.	Sand and Gravel	London.
McPhail & Wright Construction Co., Limited	Sand	Sault Ste. Marie.
Mallory, Wm. B.	Sand and Gravel	Sebringville, R.R. 1.
**Maple Sand, Gravel and Brick Co., Limited	Sand and Gravel	Toronto, 178 Spadina Ave.
Morrison, J. H. I.	Sand and Gravel	Brockville.
Ollman Bros.	Sand	Hamilton, Macklin St.
Oneida Lime Co., Limited	Glass Sand	Buffalo, N.Y., 406 Erie Co. Bldg.
Ontario Malleable Iron Co., Limited	Sand	Oshawa.
Ontario Sand Company	Sand and Gravel	Niagara Falls.
Ponsford, A. E.	Sand and Gravel	St. Thomas, 605 Talbot St.
Porter, Thompson	Sand and Gravel	Mount Dennis, 866 Weston Rd.
*Quigley, O. E.	Moulding and Core Sand	Hamilton.
Rideau Canal Supply Co.	Sand	Ottawa.
Robinson, A.	Sand and Gravel	Lindsay.
Rocsand Company, Limited	Sand and Gravel	Erin.
Sand and Supplies, Limited	Sand and Gravel	Toronto, 103 Bay St.
Sleemon, Philip	Gravel	Port Hope, R.R. 1.
Smith, J. W.	Gravel	Leamington.
Soo Dredging and Construction Co., Limited	Gravel	Sault Ste. Marie.
Soo Dredging and Towing Co.	Gravel	Sault Ste. Marie.
Stamford Sand Co.	Sand	Niagara Falls, 268 Victoria Ave.
Standard Gravel Co., Limited	Gravel	Niagara Falls, 52 Erie Ave.
Stothart, J.	Sand and Gravel	Peterboro, R.R. 6.
Thomas, W. H.	Gravel	Oshawa.
Tombling, W. J.	Sand and Gravel	Ottawa.
Twin City Tug Line	Sand	Port Arthur, P.O. Box 42.
Union Stock Yards, Limited	Sand and Gravel	Toronto.
United Fuel and Supply Co.	Gravel	Detroit, Mich.
Windsor, Essex & Lake Shore Rapid Railway Co.	Sand and Gravel	Kingsville.
Windsor Sand & Gravel Co., The, Limited	Sand and Gravel	Walkerville.
Wood, J. T.	Sand and Gravel	Exeter.
York Sand and Gravel Co., Limited	Sand and Gravel	Toronto, 445 Gladstone Ave.

* Moulding sand producers.
† Washing and screening plants.
** Screening plant.

Stone

There is no lack of stone in Ontario, and there are many kinds. Granite, gneiss, trap, sandstone, limestone, dolomite, quartz, marble, all may be had in abundance, according to locality. In southwestern Ontario the sedimentary formations furnish first-class building material both in sandstone and limestone, and a plentiful supply of the latter for the multifarious uses to which it is put—lime-making, as a fertilizer, in the chemical industry, etc., while granite and trap for street and road-making can be quarried in eastern and northern Ontario. Quartz and quartzite occur, especially on the north shore of Lake Huron and the islands adjoining, and beds of variegated and beautiful marble ranging in colour from white to mauve and red exist in some of the eastern counties.

The total production of stone, excluding quartz, which is given separately, had a value of $939,052, as against $755,312 in 1916.

Stone Production

Classified according to variety rather than uses, the quarry products of the Province for 1917, together with comparative values for the two preceding years, were as follows:—

——	Limestone.	Sandstone.	Trap.	Granite.	Marble.	Quartz
	$	$	$	$	$	$
1915...........	587,000	5,500	32,100	15,500	10,600	142,354
1916...........	625,628	14,268	91,762	23,655	....	223,514
1917...........	728,975	115,932	70,570	25,575	....	358,674

Below are given the names of quarry operators reporting a production for 1917, classified according to product:—

LIMESTONE AND SANDSTONE QUARRIES, 1917.

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Beachville White Lime Co, Limited...........	Beachville	Limestone.
Bergin, Patrick	Napanee	do
Britnell & Co., Limited	Burnt River	do
Canada Crushed Stone Corporation, Limited..	Dundas	Limestone and Sandstone.
Canadian Towing and Wrecking Co., Limited..	Port Arthur	Rubble.
Contractors' Supply Co., Limited	Orangeville	Crushed Limestone.
Cook, J. S.	Wiarton	Limestone.
Crushed Stone, Limited	Kirkfield	Crushed Limestone.
Farr, Mrs. C. C.	Haileybury	Limestone.
Hagersville Crushed Stone Co., Limited	Hagersville	do
Hamilton, Corporation of	Hamilton	do, crushed.
Henderson Farmers' Lime Co.	Woodstock	do, ground.
Kingston, Corporation of	Kingston	do, crushed.

LIMESTONE AND SANDSTONE QUARRIES, 1917.—*Continued.*

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Longford Quarry Co., Limited	Longford Mills	Limestone.
MacDonald, Jos. H.	Point Anne	do
Markus, Wm., Ltd.	Pembroke	do
Michigan Central Railway	Hagersville	do
Oliver-Rogers Stone Co., Limited, The	Owen Sound	do
Ontario Rock Co., Limited	Rossmore	do
Ontario Stone Corporation, Limited	Uhthoff	do
Perkins, Geo. A.	Owen Sound	do
Point Anne Quarries, Limited	Point Anne	do
Queenston Quarry Co., Limited	St. Davids	do
Reid, C. F.	Odessa	do
Robertson, D., & Company, Limited	Milton	Sandstone.
Robillard, H., & Son	Ottawa	Limestone.
Roddy & Monk	Kingston	do
Solvay Process Co., The	Amherstburg	do
St. Marys Horse Shoe Quarry, Limited	St. Marys	do
Standard Crushed Stone Company, Limited	St. Davids and Windmill Point	do
Standard White Lime Co., Limited	Beachville, Guelph and St. Marys	do
Thibault, Adelard	Billings Bridge	do
Walker Bros.	Thorold	do
Welland County Lime Works Co., Limited	Port Colborne	do
Wentworth Quarry Co., Limited	Vinemount	do

GRANITE AND TRAP QUARRIES, 1917.

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Brown, Robert	Lyndhurst	Granite.
Bruce Mines Trap Rock Co., Limited	Bruce Mines	Trap.
Gordon Granite Co., D. J.	Gananoque	Granite Blocks and Monuments.
Horne, Wm.	Ignace and Butler	Granite Blocks and Monuments.
National Potash Corporation, Limited	Gravenhurst	Crushed Granite.
Ontario Rock Co., Limited	Preneveau	Trap.

Actinolite

Some 120 tons of actinolite from stocks on hand were shipped by the Actinolite Mining Company, Limited, whose mine is situated at Actinolite, in the county of Hastings. The product was valued at $1,320, and was intended for use in the manufacture of roofing material.

Asbestos

From a deposit in the township of Deloro, near Porcupine, the Slade-Forbes Asbestos Company shipped 10 tons of asbestos valued at $2,150. A total of 800 tons of asbestos rock was mined during the season.

Barite

In the township of Langmuir, Porcupine Mining Division, the Premier Langmuir Mines, Limited, has been developing a barite property about 30 miles from the Timiskaming and Northern Ontario Railway. The vein is a large one and carries a little silver. A mill for grinding the barite and preparing it for market is being erected and will shortly be in operation. Mr. J. A. McIntosh, of Toronto, is president of the company.

Barite occurrences have long been known to exist in eastern Ontario, principally in the counties of Frontenac, Lanark, and Hastings, also on McKellar Island, Lake Superior, and on the north shore of that lake. Some of these have been worked, but there has been little or no production of late years. More recently, deposits have been found in the Fort Matachewan gold area, some of which are described by A. G. Burrows.[1] These comprise the Biederman' claim, in Cairo

Premier Langmuir Mines, Ltd., Plant, fall of 1917. Narrow gauge track from 2nd vein and also to dock ½ mile distant on Night Hawk river.

township, and a deposit near Yarrow lake, in Yarrow township. Another deposit has recently been reported from the township of Lawson.

Barite (or barytes) is a heavy white mineral, sometimes coloured by impurities, having the composition $BaSO_4$. It may be granular, or in masses of wedge-edged crystals, and occurs in veins in limestones and sandstones, also associated with lead or other ores. White bleached and floated ground barite is used in ready-mixed paints, in making rubber goods, and in stiff, heavy cardboards and papers. In the intermediate form of "lithopone," a growing use is found for barite in the preparation of "flat" wall paints, in rubber manufactures, and also in enamel and calcimine. A variety of barium chemicals, such as the chlorate, chloride, nitrate, etc., serve a number of uses; the chlorate and nitrate in pyrotechnics, the chloride as a water softener, in the purification of table salt, etc. Barium monoxide, and

[1] Bulletin No. 34, Ont. Bur. Min., 1918, pp. 27-8, The Matachewan Gold Area, republished in this Report.

dioxide have also their uses. As "blanc-fixe" or permanent white, barite is extensively used as an adulterant of white lead, also in making putty.

A barium industry is rapidly developing in the United States, the principal deposits there being in the States of Georgia, Missouri, and Tennessee. The native article has already taken the place of imports from Germany, which before the war largely supplied the wants of eastern manufacturers, coming in as crude by cheap ocean transportation. Crude barite in 1916 was produced in the United States to the extent of 222,000 short tons, valued at $1,011,000, or about $5 per ton. The value of the domestic barium products was upwards of $8,500,000.

Corundum

Mining was continuous throughout the year at the property of the Manufacturers' Corundum Company, Limited, Jewellville, but as the ore can only be hauled

Premier Langmuir Mines, Ltd., showing 6-foot barite vein, summer of 1917.

out over the winter roads, the concentrating mill ran only from January 24 to July 25. The quantity of corundum ore mined was 6,799 tons, and of grain corundum produced 188 tons, valued at $31,213. The employees were 46 in number, and the wages paid them amounted to $33,817.

Feldspar

The production last year was 18,334 tons, an increase of 5,369 tons over that of 1916. The value was $81,802, or $4.45 per ton, compared with $3.25. The principal site of the feldspar industry is on the line of the Kingston and Pembroke railway, in the county of Frontenac. Feldspars, Limited, and Feldspar Quarries, Limited, the former at Hartington, and the latter in the township of Portland, were the leading producers. Eureka Flint and Spar Company also quarried considerable spar at Verona and exported it to Trenton, N.J. The output has hitherto found a market as crude rock in the pottery manufacturing trade in New Jersey

and Ohio, but the product of the largest mine is at the present time being entirely used in making insulating material for use in the U.S. army. There is now a grinding mill at Parham, which supplies the Canadian trade with ground spar. The Canada Feldspar Corporation, Limited, near Fermoy, and Stephen Fitzpatrick and Company, in the township of Herschel, quarried and shipped small quantities of feldspar. The last-named company did mostly development work, and claims to have exposed three varieties of spar, namely, the red or pink potash variety, white spar, and greenish soda spar. The National Potash Corporation, Limited, Gravenhurst, has a stone-crushing plant at Muskoka Wharf, and is installing a plant with the view of extracting potash from the feldspar which occurs on the property. The works are not yet in operation.

The companies producing feldspar in 1917 were as follows:—

FELDSPAR PRODUCERS, 1917.

Name.	Location of Deposit	P.O. Address.
Canada Feldspar Corporation, Limited....	near Verona	Toronto, 168 Madison Ave.
Eureka Flint & Spar Co., The	Verona	Trenton, N.J.
Feldspars, Limited	Bedford tp.	Hartington, R.R. No. 1.
Feldspar Quarries, Limited	Portland tp.	Toronto, 33 Richmond St. W.
Fitzpatrick & Co., Stephen	Herschel tp.	Toronto, 79 Adelaide St. E.
Kingston Feldspar & Mining Co.	Verona and Godfrey	Kingston.
National Potash Corporation, Limited ...	Gravenhurst	Toronto, 178 Spadina Ave.

Fluorspar

A little fluorspar has in the past from time to time been extracted from the deposits known to exist near Madoc, in the county of Hastings, but the demand was never great, and this branch of the mining industry could scarcely be said to have an existence. The war has changed this, and the call for fluorspar, which began to be heard in 1916, continued into 1917 even more loudly. Previous to 1916 there had been no production since 1911, when 30 tons were reported as extracted, valued at $200. In 1916 shipments were 1,283 tons, and in 1917, 4,327 tons. The selling price rose concurrently. In 1911 shipments were valued at $6.66 per ton, in 1916 at $7.90 per ton, and last year at $15.13. The demand came from steel manufacturers for use as a flux.

The veins of fluorspar worked last year were near Moira lake, in the townships of Madoc and Huntingdon, and a fuller account of the deposits, together with a map showing their exact locality, will be found on a later page in the report of the Chief Inspector of Mines. The number of employees was 56, and the wages paid for labour $29,582.

Fluorspar has recently been found in quartz veins in the townships of Alma and Cairo, near Fort Matachewan, Northern Ontario. The deposits are small. They are described by A. G. Burrows in his report on the Fort Matachewan gold

area.[1] Here the mineral is of a purple colour, while in the Madoc deposits the tint is a sea-green or white.

Following were the operating individuals and firms:—

FLUORSPAR SHIPPERS, 1917.

Name.	Location.	Address.
Cross & Wellington	Lot 11, Con. XIII, Huntingdon	Madoc.
Gillen & Henderson	Lot 7, Con., XIII, Huntingdon.	Madoc.
Herrington, Herbert S.	Lot 2, Con. XII, Huntingdon.	Madoc.
Mineral Products, Limited	Lot 2, Con. III, Madoc	Madoc.
O'Reilly Company	Lot 6, Con. I, Madoc	Madoc.
Wallbridge, Mrs. Jane	Lot 4, Con. I, Madoc	Madoc.
Wellington & Munro	Lot 13, Con. XII, Huntingdon	Madoc.
	Lot 1, Con. I, Madoc	Madoc.

Graphite

The output of refined graphite in 1917 was somewhat less than in 1916, being 3,173 tons, as against 3,416. The valuation, $210,018, was also slightly less, the average per ton being $66.18, as compared with $73.06. Black Donald Graphite Company, Limited, and Globe Graphite Mining and Refining Company, Limited, were the two operating companies. The mine and mill of the former are at Whitefish lake, Brougham township, and of the latter at Port Elmsley, on the Rideau canal. Employees in the mines and works numbered 156, to whom wages amounting to $120,083 were paid.

The uses of graphite are numerous. They include the manufacture of lubricants, lead pencils, foundry facings, stove polish, paint, etc. Crucibles and high grade lubricants are made from the flake variety, which commands the highest price; for other uses the amorphous variety is employed. Hitherto there has been a considerable demand for crystalline flake for the manufacture of crucibles to be used in making special grades of steel, and the demand was chiefly for the Ceylon product, importation of which has been cut off. However, the tremendous requirements of the war for steel have brought about changes in the steel trade. The crucible method of manufacture, with its small units and limited capacity has been side-tracked, and this has lessened the demand for the higher grades of graphite. Moreover, the necessity for war material is imperious, and ordinary industrial needs are forced to take second place. In consequence, foundry operations other than munitions have been much curtailed, and a smaller quantity of the lower grades for facing purposes suffices. These conditions have had their natural effect upon the graphite industry, especially since the beginning of 1918, and the present outlook is for a diminishing production.

[1] Bulletin No. 34, Ont. Bur. Min., 1918, The Matachewan Gold Area, p. 25.

Following is a list of graphite operators:—

GRAPHITE OPERATORS, 1917.

Company.	Location of Mine.	P.O. Address.
*Allan, J. G.	near Denbigh	Hamilton, 27 Hillcrest Avenue.
*Beidelman, J. C.	Lyndoch tp.	Montreal, P.Q., 29 Cote des Neiges Road.
Black Donald Graphite Co., Limited	Brougham tp.	Calabogie.
*National Graphite, Limited	Monteagle tp.	Toronto, 402 Lumsden Building.
The Globe Graphite Mining and Refining Co., Limited	Port Elmsley	Syracuse, N.Y., U.S.A., 410 Dillaye Building.
*Tonkin-du Pont Graphite Co., Limited	Maynooth†	Phoenixville, Pa., U.S.A., 309 Church St.

* Idle in 1917. † Refinery at Wilberforce.

Gypsum

The production of gypsum is confined to the deposits in the valley of the Grand river, where the Caledonia mine, in Seneca township, and the Martindale mine, in Oneida township, are now owned and worked by the Ontario Gypsum Company, Limited, an amalgamation of the Alabastine Company and Crown Gypsum Company, which became effective January 1, 1917. Crushed and calcined gypsum to the extent of 48,943 tons were shipped during the year, the value of the same being $130,138. This compares with 36,668 tons, worth $116,206, in 1916. The number of employees was 70, who received as wages $59,966.

Gypsum, ground but not calcined, is employed as a retarder in Portland cement, as land plaster, as paint material, and for other minor uses. After being calcined, it is made into wall plasters of various kinds, into dental plaster, and is also sold to glass factories. It is used in this form in Portland cement. Other uses are the manufacture of statuettes and similar objects. Combined with fibrous material it is made into building blocks, for whose fire-resisting qualities much is claimed, because of the non-conducting and non-expanding properties of gypsum.

Very large beds of gypsum are found on the banks of several of the rivers running into James bay, but these are as yet too remote for utilization.

Iron Pyrites

In few departments of the mineral industry have the demands of war had so noticeable an effect as in the mining of iron pyrites. Sulphuric acid is a prime requisite in the manufacture of explosives. Prior to the war much of the sulphur required for making the acid was supplied by the sulphur deposits of Sicily, remains of the ancient volcanic forces once active in that island. The entrance of Italy into the war and the diversion and destruction of ships stopped the transatlantic exports, and the output of sulphur from the mines on the Mexican Gulf was insufficient for the requirements of the ammunition factories of the United States and Canada. This condition was doubly emphasized when in April, 1917, the United States joined the Allies. The pyrite deposits of Ontario being close at

hand and conveniently situated for water transportation, were called upon to make good a large part of the deficiency. Shipments of pyrite from this Province rose from 107,258 tons in 1914 to 145,315 tons in 1915, 175,593 tons in 1916 and 286,049 tons in 1917. The probability is that in 1918 the rate of increase will be maintained. Like practically all products, mineral and other, the price has risen materially. In 1915 the producers returned their output at a valuation of $2.43 per ton, in 1916 at $2.68 per ton, and in 1917 at $3.88. The following figures show how greatly the war has stimulated the mining of pyrite in Ontario:—

IRON PYRITES PRODUCTION, 1913 TO 1917.

Year.	Production.	Value.	Valuation per ton.
	tons	$	$
1913	71,620	171,687	2.39
1914	107,258	264,722	2.46
1915	145,315	353,498	2.43
1916	175,593	471,807	2.68
1917	286,049	1,111,264	3.88

It will thus be seen that in five years the output of iron pyrites has increased in quantity four times and in value more than six times.

The list given below enumerates the operators for 1917. The Nichols Chemical Company, Limited, was much the largest producer, from its mines at Northpines and Goudreau, the former near the junction of the Grand Trunk Pacific railway and the Fort William branch, and the latter on the line of the Algoma Central, in the Michipicoten area. The Nichols Company is the Canadian arm of the General Chemical Company of the United States. It also operates a mine and acid plant at Sulphide, Hastings county. The Rand Consolidated Syndicate is working a deposit at Goudreau. At Flower station, on the Kingston and Pembroke railway, the mine opened by T. B. Caldwell has passed under a working lease to the Grasselli Chemical Company, Limited. A quantity of ore was mined in 1917, but no shipments made.

The proportion of sulphur in the pyrite shipped from the mines varies from 31.76 to 45 per cent. The average in the shipments for last year was in the neighbourhood of 35 per cent., hence the sulphur contents would amount to upwards of 100,000 tons. This would be the equivalent of 300,000 tons of ordinary strong sulphuric acid. It is expected that about one-third of the total pyrite requirements of the United States for 1918 will be obtained in Ontario.

Notwithstanding the comparative abundance of pyrite in Ontario, considerable quantities of elemental sulphur are yearly imported into this Province, partly for use in manufacturing sulphuric acid, but mainly to be converted into sulphurous acid needed in making wood pulp. It would seem that in northern Ontario, where the mining of pyrite and the manufacture of pulp and paper are both carried on, it should be possible to substitute the native for the imported article, and to effect economy in doing so.

The number of workmen employed in the pyrite industry was 580, of whom 209 were engaged in underground work, and 371 above ground. They were paid wages totalling $583,819.

IRON PYRITE SHIPPERS, 1917.

Name of Owner, Firm or Company.	Location or Name of Mine.	P.O. Address of Manager, etc.
Algoma Steel Corporation, Limited	Helen	Sault Ste. Marie.
Canadian Sulphur Ore Company, Limited.	Queensboro	Toronto, Crown Office Building.
Nichols Chemical Company, Limited (*a*)	Goudreau	Goudreau.
Nichols Chemical Company, Limited	Sulphide	Sulphide.
Nichols Chemical Company, Limited (*b*)	Vermilion Lake	Northpines.
Rand Consolidated Syndicate	Goudreau	Buffalo, N.Y., 853 Ellicott Square.

(*a*) Formerly known as The Madoc Mining Company.
(*b*) Formerly known as The Northern Pyrites Company, Limited.

Mica

During 1917 shipments of mica were made by producers of both rough-cobbed and thumb-trimmed grades. Of the former 40 tons, worth $7,100, were marketed, and of the latter 790,905 lbs., worth $85,353, or a total of 435 tons valued at $92,453.

Owing to labour scarcity, mining operations have been curtailed, but a great deal of dump material has been sorted and marketed. A shortage of mica is in prospect owing to the large demand for this material for war purposes, and also to the limited production. The Loughborough Mining Company, Limited, Kent Bros., and estate of J. M. Stoness, S. H. Orser, and A. G. Martin were among the larger producers.

There were 88 employees at work during the year, who were paid $48,490 in wages.

Shipments were made by the following during 1917:—

MICA PRODUCERS, 1917.

Name of Owner or Producer.	Location or Name of Mine.	P.O. Address of Manager, etc.
Anglin Mica Co.	....	Kingston.
Buck Lake Mining Co.	Loughborough tp.	Perth Road.
Fahey & Sullivan	South Crosby tp.	Elgin.
Grierson & Gallagher	North Burgess tp.	Perth, R.R. No. 5.
Kent Bros. and Estate J. M. Stoness	Bedford tp.	Kingston.
Loughborough Mining Co., Ltd.	Lacey mine	Sydenham.
McConnell, Rinaldo	North Burgess tp.	Toronto, 1002 Kent Bldg.
McLaren, W. L.	North Burgess tp.	Perth.
Martin, A. G.	Connors Mine, Portland.	Ottawa, 234 Besserer St.
Orser, S. H.	North Burgess tp.	Perth.
Sydenham Mica and Phosphate Mining Co., Limited	Loughborough tp.	Perth.
Tett & Bro., J. P.	Bedford tp.	Bedford Mills.
Waffle, W.	....	Westport.
Webster & Co.	North Burgess tp.	Ottawa, 274 Stewart St.

Natural Gas

The total amount of natural gas produced in Ontario during the year was 20,026 million cubic feet.

In the following table of distribution by fields, compiled by the Mine Assessor, the yield from a number of very small operators is not included.

	Million cubic ft.		
1. Welland, Haldimand, etc., field	3,760.2	or 19.2	per cent.
2. Kent field (old field)	15,229.7	77.9	
3. Kent, new field (Dover Tp.)	220.7	1.1	
4. Elgin	290.8	1.6	
5. Lambton	44.6	0.2	

The old field situated in Welland, Haldimand, Norfolk, Wentworth and Brant counties has now produced 61,432 million cubic feet. Small new pools are discovered from time to time but are not sufficient to compensate for the decline in output of the old wells, and the outlook for an increase of gas from this section is not bright. The most promising area of substantial size left for exploration is at Long Point, where drilling is now going on.

The Kent field in Romney, Tilbury and Raleigh townships has again been the mainstay of the production, and the yield from this field to the end of 1917 amounts to 81,030 million cubic feet. This is equivalent in heating value to 4,000,000 tons of coal approximately. The course of events in this field is dealt with at length below.

The new field in Dover township came into operation for the first time last year. The gas is found in the Trenton at a depth of about 3,300 feet and is associated with oil.

The Elgin field has been described at length in previous Reports, and there is nothing new to record. The production from Elgin county now amounts to 2,556.2 million cubic feet.

The Lambton field at Oil Springs has unfortunately had a short life; the production has fallen to 670.6 million cubic feet, and is rapidly declining each year.

Noteworthy events have taken place since the beginning of 1918 in the Kent county natural gas field, affecting the social and industrial life of the community. Failure of gas supply, concurring with an unusually severe winter, led to much hardship and even suffering among the many thousands of people in southwestern Ontario who have come to depend upon gas for that primal necessity of human life, fuel. The use of gas for heating and cooking purposes has become well nigh universal in the cities, towns, villages and even farms which have access to a supply. It makes no ashes and little dirt, is easy to turn on and off, and it is cheap. But an increasingly large proportion of the gas has been going to manufacturers, many of them using large quantities in the coarser and heavier industries, and getting their gas at a much lower rate than domestic consumers. The feeling has for some time been growing that natural gas should be treated as a fuel for household consumption only, and the crisis last winter led to an outcry against the manufacturing and industrial use of gas. Strong representations were made to the Government, and the Legislative Assembly with practical unanimity passed

an Act handing over the control of the natural gas supply to the Ontario Railway and Municipal Board.

The Natural Gas Act, 1918

G. R. Mickle, Mine Assessor, who supervises the inspection of gas and oil wells in the Province on behalf of the Department, and whose duties have made him familiar with the gas situation deals with it as follows:—

The most important event in the year affecting the natural gas industry was the failure of the Kent gas field to respond to the ever increasing and exorbitant demands made on it, and the consequent break-down of the whole system, causing a shortage of gas in many homes, with the inevitable suffering this entails. The government was petitioned to bring the matter before the Ontario Railway and Municipal Board. This was done, and a sitting of the Board was held in Chatham about the middle of January. In consequence of the Board's report the Natural Gas Act of 1918 was passed. This Act places the regulation of the natural gas output in the hands of the Ontario Railway and Municipal Board. Under the powers conferred by the Act the Board ordered natural gas to be cut off from a number of industries till the 1st of April. This Order was made about the middle of February. From 1st April to 1st July industrial consumers with a few exceptions were allowed to use the same amount of gas as they had consumed during the same months last year. On 1st July a general order was issued by the Board largely confining the use of gas to domestic purposes, and greatly restricting its industrial use. The only use of natural gas for power permitted by this order is for the highly economical gas engine, and in methods and appliances which ordinarily are served with artificial gas, which is nowhere cheap. The amount that may be so used by any company is limited to 5,000,000 feet per year. At the same time, pending changes during the transition period, permits were issued by the Board for a supply of gas to carry on operations while plants are being reconstructed to use other fuel.

Assuming the policy outlined to be continued, the result must be a prolongation of the life of the field for the benefit of the domestic consumers now using gas. With the high prices now prevailing for the most convenient solid domestic fuel, and the difficulty of securing hard coal even at $11.00 per ton, this is certainly a great boon to all the communities now served with natural gas.

Difficulties in Regulation and Public Control

The history of the Kent gas field does not differ essentially from that of any other field yielding gas. The difficulty is in the nature of the product, which is unlike anything else with which we are accustomed to deal. The essential difference, and the root of all the trouble, lies in the fact that there is no physical means by which the holder of one piece of land can be prevented from drawing gas from adjoining territory. If the holder of a lease could be assured of his ability to draw off the gas underlying his leases, which rightfully belongs to him, and to utilize it in the most economical manner, there would be no excuse for entering into a crazy competition to exhaust the field as quickly as possible, and sell the gas at any price rather than let a competitor have it. This condition inevitably leads to some public control of production and distribution as the only possible solution of the difficulty. There does not seem to be any insurmountable obstacle in the way of determining what proportion of the total amount of gas in reserve underlies any particular set of leases, and consequently what percentage of the total production permissible should be allotted to any one company.

Boyle's Law and Natural Gas

This law, if properly understood and followed, is a certain guide in planning the rate of production that should be permitted in any gas field. The rate of production should, of course, be governed by the amount of gas which exists in any field, of which Boyle's law is a sure means of measure. The expression so often used of the "uncertainty" of the gas supply is absurd when the rock pressures and production are studied in the light of this law. So far from being uncertain, the amount of gas existing in a field can be calculated within reasonably close limits years before the point of exhaustion is reached. As this law is the most important thing in connection with natural gas and has been disregarded, it seems worth while to explain it at some length, and show its application in planning a rational scale of production from any field. Considering that Boyle's discovery of the law that bears his name was announced in 1660—over 250 years ago—and has appeared in every text-book on physics for generations, it is surprising that it is so generally ignored. Boyle called his discovery the "Doctrine of the Spring and Weight of the Air," the spring, or pressure as we would now say, being due to the weight. In his work called "The Defence of the Doctrine of the Spring and Weight of the Air," the following passage, which seems

to forecast the general attitude towards the natural gas question, occurs: "I see no cause to despair that, whether or no my writings be protected, the truths they hold forth will in time, in spite of opposition, establish themselves in the minds of men, as the circulation of the blood, and other formerly much contested truths, have already done."

It has been a long wait.

Let us imagine that a tank or container is constructed of glass as illustrated in fig. 1 with dimensions of 10 ft. by 10 ft. by 10 ft., so that it contains exactly 1,000 cubic feet. Suppose this to be first filled with water, and provided with a pipe to form an inlet for gas and another pipe as an outlet for the water. Now allow natural gas or air or any other gas to enter slowly and displace the water. In fig. 1 the point of time is shown when the water is about half gone. Allow the gas to flow in slowly till the water is all gone, then instantly close both inlet and outlet. The tank will of course contain exactly 1,000 cubic feet of natural gas, and the pressure gauge will read zero, although there is a pressure in the tank exactly equal to the atmospheric pressure which the gauge does not record. This is shown in fig. 2. This atmospheric pressure is known to be approximately 15 lbs. to the square inch, and in considering the relation between volume and pressure we should start from the absolute zero, or add 15 lbs. approximately to the gauge reading. Thus if we wish to calculate the difference in volume between gas at atmospheric pressure or zero on the gauge, and 6 oz. on

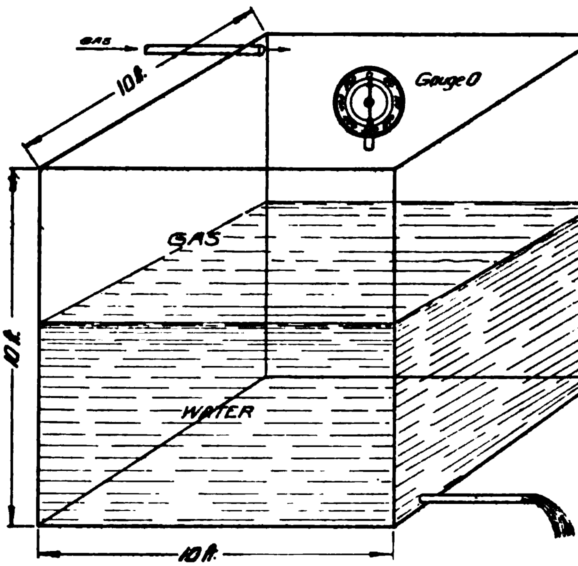


Fig. 1.—Diagram showing method of replacement of water by gas.

the gauge, add 15 lbs to each, then, reducing both to ounces, we have respectively pressures of 240 oz. and 246 oz., and there will be 2.5 per cent. more gas at the 6 oz. gauge reading than there was at the zero reading, as will be seen later on.

Coming to fig. 3, the gas has been passed into the tank till the gauge reads 15 lbs. or 30 lbs. above the absolute zero; that is, there is a pressure of two atmospheres above zero, and there will be exactly 2,000 cubic feet of gas in the tank. Therefore the pressure counting from the zero point has been doubled, and the volume occupied by the first 1,000 cubic feet in the tank has been reduced to one-half. Boyle's law is often expressed in this way: pv = constant, that is, where p = pressure and v = volume, the product of the two is always the same. The original 1,000 cubic feet is compressed into one-half the space it occupied at zero gauge or atmospheric pressure, and so on. Each increase in pressure of an atmosphere means that an amount of gas equal to the volume of the container or tank, in this case 1,000 cubic feet, has been added. Fig. 4 shows the tank with a gauge reading of 590 lbs., or approximately 40 atmospheres, and consequently the tank will contain 40,000 cubic feet of gas. This was the rock pressure that originally existed in the Kent field. And it would make no difference if, instead of having one clear space of exactly 1,000 cubic feet, the tank had been made larger and then gravel and sand thrown in till the aggregate pore space equalled 1,000 cubic feet.

The tank, having been filled, can be emptied in exactly the same way; every atmosphere drop in pressure means that 1,000 feet have been drawn off. Fig. 5 illustrates the state

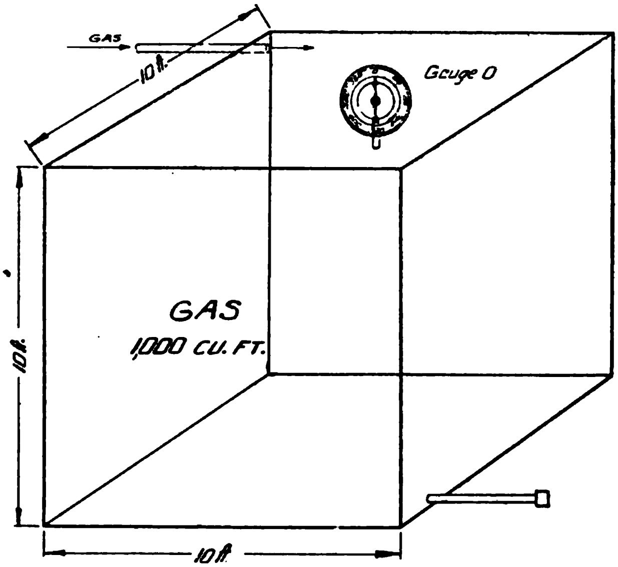


Fig. 2.—Diagram shows condition at instant all water is replaced.

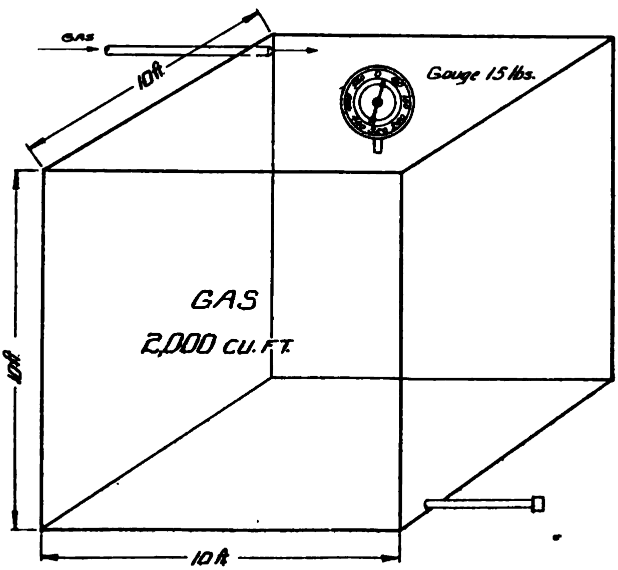


Fig. 3.—Pressure in tank now two atmospheres above absolute zero, or 15 lbs. on gauge.

of affairs existing at the present time (1st June, 1918) in the Kent field when, as explained below, the average gauge pressure was found to be 320 lbs, or 22 atmospheres approximately.

Turning now to the gas field, let us regard it, as it should be regarded, as a container or tank, and not as some mysterious geological anticlinal structure. We have not one solid chamber full of gas, but a condition resembling the case imagined above, namely, a tank of dimensions of several thousand cubic feet filled with sand and gravel to such an extent that finally the aggregate volume of the spaces between the sand and gravel is equal to 1,000 cubic feet. And in this field tank, instead of one pressure gauge we have a gauge on each well, of which there are about 300 distributed all over the field, so that the average pressure is capable of close estimation. According to Boyle's law, for each increase or decrease of pressure of one atmosphere in the imaginary tank, and counting from the absolute zero, 1,000 cubic feet have been added to or drawn from the tank. In an exactly similar way, a loss of one atmosphere in pressure means a loss in our field tank of a certain number of cubic feet which is exactly the volume or cubical space contained in the tank that might be occupied by gas. It will be seen that as the gas is drawn from the field there is a certain production of gas for each atmosphere drop in pressure, which of course gives us the aggregate volume of all the pore space in the rock constituting the tank or gas field. It is evident that the proper rate of production to ensure an economical use of the supply of gas could have been estimated at least six years ago, and that the loss occasioned by increasing the production according to the demand beyond the capacity of the field was quite unnecessary.

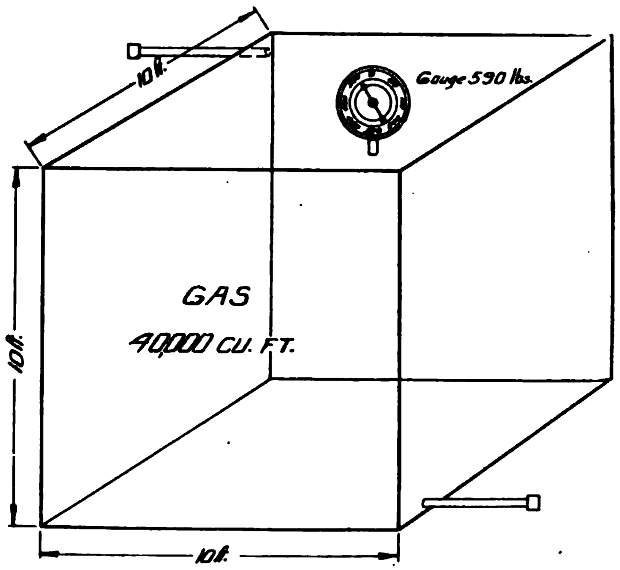


Fig. 4.—Pressure increased to 40 atmospheres.

Relation Between Drop in Pressure and Output of the Field

Up to 1st June, 1918, the production of the Kent gas field was 86,450 million cubic feet approximately, this being made up of the production to the end of 1917 of 81,030 million cubic feet, and an estimated production of 5,420 million feet from 1st January to 1st June, 1918. During this production the rock pressure dropped from 590 lbs. to 320 lbs. on 1st June. or a loss of 270 lbs. This determination of the average rock pressure was made by the writer with great care, the field being subdivided into a number of areas in which the rock pressures were fairly uniform, and a weight being given to each area proportionate to its size, and also to the average open flow capacity of the wells in each area.

This 270 lbs. drop in pressure is equivalent to 18.75 atmospheres at 14.4 lbs. per atmosphere, that being the atmospheric pressure at the altitude of the gas field. The output for each decline of one atmosphere in pressure is accordingly 4,610 million cubic feet, which is the aggregate volume of the pore space in the rock. It is naturally more easy to closely calculate the relation between the loss of pressure and the output, the more nearly the field approaches the point of exhaustion. When the pressure is down to nearly zero, and the field is abandoned, we will know exactly the relation between the two, but the knowledge will then be of little value.

For all practical purposes, however, it can be seen that the relation between decline in pressure and output, and consequently the rate of production which should be allowed, was known and published with sufficient accuracy years ago. Thus from information given in various Reports of the Bureau of Mines, it can be seen that at the end of 1912 the production from the Kent field was 23,132 million cubic feet, with a loss in pressure of about 90 lbs., or 6.2 atmospheres, or 3,730 million feet per atmosphere, or a difference of 20 per cent. from the amount finally calculated. At the end of 1913 the output was 31,108 million feet, with a loss in pressure of 8 atmospheres, or 3,888 million feet per atmosphere, a difference of 16 per cent. from the standard. Taking the year 1913 alone, which of course would give an independent check, the production was 7,976 million feet and a decline of 1.8 atmospheres, or 4,431 million feet per atmosphere, a difference of 5 per cent. from the final estimate. The output from 1913 to June, 1918, was 55,342 million feet and drop in pressure 10.75 atmospheres, or 5,148 per atmosphere, or 12 per cent. variation from the final figures.

In the case of all these estimates, previous to 1918, no special effort was made to accurately determine the rock pressure and the output at any given date, which of course would be necessary in order to establish the relation between the two. The records of production are kept according to the calendar year, whereas the most convenient time to take the rock pressures is in midsummer, when the wells are not working at the fullest capacity, consequently any of the figures given previous to 1918 are only approximations.

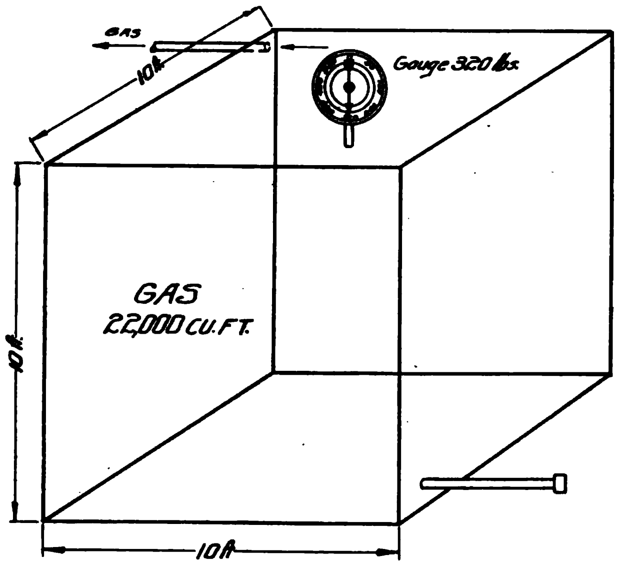


Fig. 5.—Shows condition of Kent field at present with about 22 atmospheres pressure.

At the end of 1917 pressure was assumed to be 320 lbs., which was evidently too low. As it is more convenient to have the end of the year as the accounting period, and 5,420 million cubic feet was the estimated production from January to 1st June, this corresponds to 1.17 atmospheres or 16.8 lbs. At the end of 1917, therefore, the pressure must have been 337 lbs., and not 320 as assumed in Sessional Paper No. 78 (1918) by the writer.

The Natural Limit to the Rate of Production for a Gas Field

In determining the annual output which should be allowed from any field, apart altogether from a consideration of the quantity which it is rational to permit, there is a maximum limit imposed by nature due to the physical conditions of the field, there being salt water in the rock underlying the gas, and this salt water being only kept back by the pressure of the gas and thus prevented entering the wells and ultimately cutting off the supply of the gas. Experience in the past has shown that where the production from a field has been accelerated too much, thereby reducing the pressure at each producing well, salt water comes in and finally shuts off the output of the well entirely. There is no way of calculating exactly what this rate should be, but it can be approximated from experience, and it would appear that a reduction of the pressure by one atmosphere per year is a natural limit. A loss of one atmosphere of pressure means that the production is exactly equal to the total volume of all the

incalculable number of pores which constitute the field tank, and consequently involves great motion. When it is considered that the gas is stored in countless millions of minute pores. and must find its way slowly owing to the great friction through vast numbers of the smallest openings, it can be seen that time is required to equalize the pressures throughout the field and not allow a very low pressure at the well which would permit the entrance of water. With a purely domestic consumption it would be possible to give the wells a rest in the summer months when the consumption is for cooking only and the output consequently very small—only from 4 to 5 per cent. altogether of the total annual domestic consumption being used in the months of July and August.

The history of the Essex gas field, which is only 20 miles from the Kent field, the gas being exactly the same in composition and therefore almost certainly having come from the same source, is instructive in this respect and should furnish sufficient warning. The Essex field was discovered in 1889, the depth of the gas being about 1,000 feet and the rock pressure 500 lbs. In the Kent field the depth of the wells is about 1,300 feet and original pressure 590 lbs. In 1900 the pressure was reduced to between 325 and 350 lbs.[1], or a maximum drop of about 12 atmospheres in 11 years. In 1901 about three-quarters of the wells were full of salt water.[2] The production in 1902 was much smaller than in 1901.[3] The export was shut off towards the end of 1901 and the field was practically abandoned in 1903.[4] The records of production are unfortunately very incomplete, but about 22,500 million cubic feet from this field appear to have been utilized,[5] and as there was an enormous waste in the early days of the field, probably not less than 30,000 million cubic feet came from this area. Of this all but about 3,000 million feet were produced before 1901, or a production of not less than 27,000 million was accompanied by a drop of 12 atmospheres pressure or 2,250 million feet per atmosphere. Assuming this field could have been operated down to 50 lbs. pressure, or a further deduction of 287 lbs. or 20 atmospheres, it should have produced 45,000 million feet after 1900, instead of about 3,000 million. It has been shown already that in the Kent field a production of 4,610 million feet corresponded to a loss of 1 atmosphere in pressure. This will be as nearly as can be determined the purely domestic consumption assuming the order of the Ontario Railway and Municipal Board is carried out. It was shown above that the total output up to June, 1918, was about 86,000 million, and if the field can be operated down to 50 lbs. pressure (the Welland field is being operated below 50 lbs.) the same amount must be left as has been produced up to that time.

It would be a great calamity if the same thing happened in the Kent as in the Essex field, and in the public interest measures should be taken to avert the threatened destruction of the supply. The estimated consumption for the first half only of 1918 is 5,880 million cubic feet, the restriction as to industrial use not coming generally into force till 1st of July. The distribution of the consumption for 1917 was 9,400 million cubic feet for industrial users and 5,829 million for all other consumers. Under the order[6] of the Board referred to above there should ultimately be an estimated saving among the non-industrial consumers of 1,457 million cubic feet per year, making the actual domestic consumption 4,372 million feet. to which must be added an estimated industrial consumption for the special purposes mentioned in the order of about 300 million feet, or a total in all of 4,672 million cubic feet. In tabular form the consumption based on the results for 1917 is as shown below:—

	Million cubic feet.
Estimated total industrial consumption, 1917	9,400
All other consumers (non-industrial)	5,829
Total	15,229
Estimated industrial consumption, January-July, 1918	2,260
Estimated non-industrial consumption, January-July, 1918	3,620
Total consumption, 6 months	5,880

[1] Ont. Bur. of Mines Rep., Vol. X, p. 19.
[2] Ont. Bur. of Mines Rep., Vol. XI, p. 43.
[3] Ont. Bur. of Mines Rep., Vol. XII, p. 38.
[4] Ont. Bur. of Mines Rep., Vol. XIII, p. 22.
[5] Ont. Bur. of Mines Rep., Vol. XXV, p. 39.
[6] A later order of the Board (August 30, 1918) permits the use of natural gas until June 1, 1919, in hospitals, sanitariums, hotels, restaurants, offices, stores, schools, churches. halls and other public buildings, also libraries, clubs, and theatres, where the same was in use during the winter of 1917-18, subject to the condition that the consumption shall not exceed that for the corresponding period of last winter. Much of the estimated saving shown above will therefore for the coming season be eliminated.

This represents a saving over the same period last year of 2,440 million cubic feet. The estimated consumption when the Board's order is completely in operation is as follows:—

	Million cubic feet.
Estimated saving by abolition of flat rate	100
Estimated saving by limitation of free users, etc.	47
Estimated saving by cutting off public buildings, offices, etc	1,310
Total	1,457
Non-industrial consumption, 1917	5,829
Deduct estimated saving	1,457
Estimated domestic consumption	4,372
Add estimated industrial consumption for special purposes	300
Total	4,672

Natural Gas Statistics

The following table summarizes the statistical information collected for 1917, and for purposes of comparison figures for 1916 are given also. The mileage of pipe lines for the non-producing companies which distribute natural gas is included in the total mileage of pipe line. In 1916 this item was not so included:—

	1916.	1917.
Gas wells drilled in year:		
Productive	135	121
Non-productive	38	52
Producing wells at end of year	1,802	1,905
Miles of pipe line	2,233	2,925
Workmen employed	653	780
Wages for labour	$404,039	$537,946
Gas production:		
Quantity (M. cu. ft.)	17,953,396	20,025,699
Value	$2,404,499	$3,220,123

The following producers of natural gas reported an output for 1917:—

NATURAL GAS PRODUCERS, 1917.

Name of Person or Company.	Producing Wells, Dec. 31, 1917.	Township.	P.O. Address of Manager, etc.
Aikins, W. J.	1	Onondaga	Dunnville.
Aldrich Gas & Oil Co., Limited	10	Rainham	Hamilton.
Azoff Natural Gas Co., Limited	1	N. Cayuga	Canfield.
Barnard-Argue-Roth-Stearns Oil & Gas Co., Limited	1	E. Tilbury	401 Iroquois Building, Buffalo, N.Y.
Beaver Oil & Gas Co., Limited	23	Romney & E. Tilbury.	Buffalo, N.Y.
Bertie Natural Gas Co., Limited	8	Bertie	Ridgeway.
Canadian Gas Co., Limited	43	Romney, Tilbury E.	1426 Dime Bank Bldg., Detroit, Mich.

NATURAL GAS PRODUCERS, 1917.—*Continued.*

Name of Person or Company.	Producing Wells. Dec. 31, 1917.	Township.	P.O. Address of Manager, etc.
Canadian Steel Foundries, Limited	8	Crowland	Thorold.
Canfield Natural Gas Co., Limited.	3	N. Cayuga	Canfield.
Chippawa Development Co., Ltd..	7	Willoughby	Chippawa.
Chippawa Oil and Gas Co., Limited	42	Caistor, Canboro and Cayuga	Tavistock.
Coleman, J. A.	4	Wainfleet	Wellandport.
Commonwealth Oil & Gas Co., Ltd.	2	Onondaga	240 King St. E., Hamilton.
Crystal Oil & Gas Co., Ltd.	1	Onondaga	Paris.
Danskin, D.	1	Brantford	Cainsville.
Darling Road Co-operative Gas Co.	6	Canboro, N. Cayuga	Canfield.
Deagle, John	1	Onondaga	Middleport.
Diener Gas & Mfg. Co., Ltd.	1	Canboro	Dunnville, R.R. No. 5.
Dominion Natural Gas Co., Ltd....	742	Lincoln, Wentworth, Elgin, Norfolk and Haldimand (counties)	842 Marine Bank Bldg., Buffalo, N.Y.
Douglas, W. A.	1	Onondaga	Caledonia.
Dunn Natural Gas Co., Limited	27	Dunn	Dunnville.
Duxbury, Wellington	1	Walpole	Hagersville.
Eastside Gas Co., Limited	7	Sherbrooke	Lowbanks.
Emerson, Troughton & Laidlaw	4	Canboro	Attercliffe Station.
Empire Limestone Co.	4	Humberstone	19 Hudson Street, Buffalo, N.Y.
Fairbank, Estate of, J. H.	1	Enniskillen	Petrolia.
Fletcher, J. I.	1	Binbrook	Hannon, R.R. No. 1.
Fisherville Gas Co., Nos. 1 & 3	2	Rainham	Fisherville.
Gas & Oil Co. of Springvale, Ltd..	2	Walpole	Hagersville, R.R. No. 4.
Grand River Oil & Gas Co.	2	N. Cayuga	Cayuga.
*Glenwood Natural Gas Co., Ltd....	80	Raleigh, Romney and Tilbury E.	Buffalo, N.Y.
Hager, Ham	1	Onondaga	Middleport.
Hamilton Gas & Oil Co., Limited..	3	Seneca	Hamilton.
Hendee Natural Gas Co.	6	S. Cayuga	Cayuga.
Home Natural Gas Co.	4	Oneida	Hamilton.
Hoover, D. E.	1	Rainham	Selkirk.
Industrial Natural Gas Co., Ltd...	38	Bertie, Crowland and Humberstone	Thorold.
Jones, James S.	3	Dunn	Port Maitland.
Jones, Nelson	2	Canboro, Moulton	Attercliffe Station.
Kindy Gas Co., Limited	7	Rainham	South Cayuga.
Kindy & Sons, D.	7	Rainham	Selkirk.
Kittinger Gas Co., Limited	5	Moulton	118 E. Eagle St., Buffalo, N.Y.
Kohler, May & Hoover	12	Canboro	Selkirk.
Lake Erie Developing Syndicate	1	Raleigh	Chatham.
Lalor, F. R.	5	Moulton	Dunnville.
Lalor & Vokes	10	Walpole	Dunnville.
Lamb, Alfred	9	Walpole	Selkirk.
Liesinger-Lembke Co.	1	Humberstone	Buffalo, N.Y.

NATURAL GAS PRODUCERS, 1917.—*Continued.*

Name of Person or Company.	Producing Wells, Dec. 31, 1917.	Township.	P.O. Address of Manager, etc.
McKillop Sons, Ltd., Kohler, May & Hoover	4	Canboro	Selkirk.
Marshall Lime & Cement Works, Jas.	15	Glanford and Seneca.	Hamilton.
Martin, Edward	3	Dunn	Dunnville.
Medina Natural Gas Co., Limited	22	Bayham	Chatham.
Mickle, Geo. T., & McKechnie, S.	5	Canboro	Ridgetown.
Midfield Natural Gas Co., Limited	7	N. Cayuga	32 Stinson St., Hamilton.
National Gas Co., Limited	72	Rainham, Seneca	119 Carrick Ave, Hamilton.
Niagara National Gas & Fuel Co., Ltd.	4	Humberstone	Fenwick.
North Shore Gas Co., Limited	14	Rainham	Merchants Bank Bldg., Hamilton.
Northwestern Gas Co., Limited	4	Brant (county)	13 Scott Block, Erie, Pa.
Oil Springs Oil & Gas Co., Ltd.	6	Enniskillen	Oil Springs.
Onondaga Oil & Gas Co., Ltd., The	6	Onondaga	Brantford.
Ontario Gypsum Co., Ltd., The	4	Seneca	Paris.
Pilkington Bros., Ltd.	5	Crowland	St. Catharines.
Port Colborne - Welland Natural Gas & Oil Co., Limited	25	Seneca, Oneida, Onondaga	Port Colborne.
Provincial Natural Gas & Fuel Co. of Ontario, Limited, The	13	Welland (county)	Niagara Falls.
Relief Gas Co., Limited	14	Gainsboro, Wainfleet.	117 Queenston Street, St. Catharines.
Richmond Gas & Oil Co., Ltd.	4	Bayham	Chatham.
Robinson Road Gas Co.	4	Canboro and Moulton	Dunnville, R.R. No. 4.
Sparham, A. F.	6	Glanford	Caledonia.
*Standard Natural Gas Co., Ltd.	45	Onondaga	Buffalo, N.Y.
Sterling Gas Co., Limited	66	Humberstone, Wainfleet, Moulton and Sherbrooke	Port Colborne.
Stevensville Gas & Fuel Co.	3	Bertie	Stevensville.
Sundy Gas Well Co.	3	Canboro	Dunnville.
Telephone City Oil & Gas Co., Ltd.	3	Onondaga	Brantford.
Union Natural Gas Co., of Ontario, Limited	124	Dover, Raleigh and Tilbury	Niagara Falls.
*United Gas Companies, Limited	53	Wainfleet, Moulton and Gainsboro	Buffalo, N.Y.
Vacuum Gas & Oil Co., Limited	2	Middleton	608 Lumsden Building, Toronto.
Vansickle, A. W.	2	Onondaga	Onondaga.
Wainfleet & Moulton Gas Co.	3	Middleton	Lowbanks, R.R. No. 1.
Welland County Lime Works Co., Limited	29	Wainfleet	Port Colborne.
Wedrick, M.	3	Walpole	Nanticoke.
Weylie & Benjamin	4	Glanford	Glanford Station, R.R. No. 2.

* Subsidiary company controlled by the Dominion Natural Gas Company, Limited, 842 Marine Bank Building, Buffalo, N.Y.

Following is a list of non-producing companies which pipe natural gas from the wells to points of consumption or who distribute it there:—

PIPE LINE COMPANIES OR DISTRIBUTORS ONLY OF NATURAL GAS.

Name of Company.	Miles of Pipe Line, Dec. 31, 1917.	Head Office.
*Brantford Gas Co., Limited	58.9	Buffalo, N.Y.
Central Pipe Line Co., Limited	60.0	Chatham.
Chatham Gas Co., Limited	30.0	Chatham.
Independent Natural Gas Co.	....	Dunnville.
*Ingersoll Gas Light Co., Limited	24.4	Buffalo, N.Y.
Lake Shore Natural Gas Co., Limited	7.1	294 Baynes St., Buffalo, N.Y.
*Manufacturers Natural Gas Co., Limited	5.6	Buffalo, N.Y.
Nelles Corners Gas Co.	....	Nelles Corners.
Northern Pipe Line Co., Limited	35.8	P.O. Box 66, Niagara Falls.
Petrolia Utilities Co., Ltd.	12.0	Petrolia.
Rosehill Natural Gas Co., Limited	2.5	15 City Hall, Buffalo, N.Y.
Sarnia Gas Co., Limited	29.0	Sarnia.
*Southern Ontario Gas Co., Limited	210.6	Buffalo, N.Y.
Tilbury Town Gas Co., Limited	12.5	P.O. Box 66, Niagara Falls.
United Gas & Fuel Co. of Hamilton, Limited	325.0	72 James St. N., Hamilton.
Wallaceburg Gas Company	....	Wallaceburg.
Wellandport Natural Gas Company	....	Wellandport.
Windsor Gas Co., Limited	71.5	33 Chatham St. W., Windsor.
*Woodstock Gas Light Co., Limited	44.1	Buffalo, N.Y.
Total	929.0	

*Company controlled by the Dominion Natural Gas Company, 842 Marine Bank Building, Buffalo, N.Y.

Gas and Oil Well Inspection

There are three oil and gas well inspectors appointed by the Provincial government to see that the regulations provided by the Legislature are observed in preventing the waste of natural gas and the proper plugging of abandoned wells. John Scott, of Petrolia, is inspector for the Lambton oil field; A. E. Near, Gas Line, for the Welland-Haldimand field, and J. W. Beno, Chatham, for Tilbury and surrounding territory. The effect of this inspection, and especially the operation of the tax on natural tax which is levied in full at two cents per thousand cubic feet when wasted, and only at one-tenth of this rate when consumed, has been to almost entirely eliminate the waste of this valuable fuel which was previously so common.

Extracts from the reports of the Inspectors follow.

A. E. Near states:—

Considerable drilling has been done during the year, especially by the two largest companies operating in this district, the Dominion Natural Gas Company, Limited, of Hamilton, and the Provincial Natural Gas and Fuel Company of Niagara Falls, Ont.

The Dominion Natural Gas Company drilled 67 wells, of which 47 were producing and 20 non-producing. They also purchased 7 wells and abandoned 44 exhausted ones, leaving them at the end of the year with 742 producing wells, from which they supplied gas to 38,812 customers.

The Provincial Natural Gas and Fuel Company drilled 13 wells in the Welland County field, of which only 4 were producing. They abandoned 13 exhausted wells, leaving them at the close of the year a total of 213 producing wells, from which they supplied their many customers in Niagara Falls, Welland, Bridgeburg, Fort Erie, Stevensville and Crystal Beach. On account of a general decline of gas this company on November 1 last ordered their customers to discontinue using gas for all furnaces and large heaters, in order to ensure an adequate supply for cooking purposes and light heating only.

In the Onondaga gas field, the Dominion Gas Company are operating 15 wells which produce oil as well as gas, and during the past year 450 barrels of oil were secured from these wells by means of pumps.

The Provincial Natural Gas and Fuel Company recently completed a gas well on the farm of A. E. O. Page in the township of Bertie at Point Albino, and secured an open flow of 500,000 cubic feet. This gas was obtained at a depth of about 3,300 feet, in the Trenton limestone.

The Sterling Gas Company of Port Colborne in November last completed two gas wells with an open flow of one million cubic feet. These wells are located in the township of Sherbrooke, in the county of Haldimand, at Lapp's Point on the Lake Erie shore a short distance east of Gull Island. This additional supply of gas is greatly appreciated by the citizens of Port Colborne and Humberstone, where the shortage of gas was experienced in the winter of 1916.

From information secured I can readily say there is without doubt a general decline of gas in pressure as well as in volume throughout this whole district.

Mr. Beno reports the following developments in the gas fields in the counties of Essex and Kent:—

In the Tilbury East, Romney and Raleigh area, the Glenwood Natural Gas Company, Limited, St. Thomas, drilled in 9 wells and 5 dry holes; the Union Natural Gas Company, Chatham, drilled 7 wells and 2 dry holes; the Canadian Natural Gas Company, Limited, Detroit, drilled 5 wells and laid 7 miles of 3-inch gas mains; the Beaver Oil and Gas Company, Limited, St. Thomas, drilled 2 wells, and the Dunegan Gas Company, Chatham, drilled 1 gas well.

In Dover West, the Union Natural Gas Company, Limited, drilled in gas well No. 1 on lot 3 in the third concession to a depth of 3,183 feet. This well came in with a rock pressure of 1,235 lbs., and a flow of 3,000,000 cubic feet of gas per day. It has since developed into a gas and oil well combined. The same company drilled four dry holes in the neighbourhood on the following lots and to the depths given: Dover township, lot 1, concession three, 3,765 feet; lot 4, concession three, 3,304 feet; lot 4, concession five, 3,265 feet; and lot 5, concession one, Tilbury East, 3,735 feet.

The Central Development Company struck a light gas flow at 1,421 feet on lot 16, concession fifteen, Raleigh township, and dry holes on lot 136 T.R.W., Raleigh, and lot 6, concession two Tilbury East, at a depth of 2,100 and 3,504 feet respectively. The Beaver Oil and Gas Company put down a dry hole 2,975 feet deep on lot 36 in the front concession of Gosfield South.

Altogether, in this field the following changes from the position in 1916 are reported: 2 oil wells, 24 gas wells and 13 dry holes drilled, also 15 miles of gas line laid down. The dry holes, in addition to 7 sunk in the Dover area, were on the following lots: Raleigh township, lot 1, concession thirteen; lot 19, M.R.N.; lot 5, concession thirteen; Tilbury East, lot 185, concession two, R.W.; Raleigh, lot 186, concession two, R.W.; lot 136, concession two, R.W.; Mersea, lot 2, concession six. Eight oil wells, 8 gas wells and 14 dry holes were abandoned, all of which were properly plugged according to the law.

The total number of gas wells being operated in this field is 280; oil wells, 34. The united length of all the gas mains, of size varying from 3 to 12 inches in diameter, is estimated at 517 miles.

Mr. Beno states that the gas supply has diminished from 50 to 60 per cent. during the last two years, by reason of the heavy draught on the wells, and opines that if this draught continues the field will soon be exhausted.

In the Lambton oil field there is a little gas, mainly at Oil Springs. There is also one well in the township of Euphemia. These have been in operation for some three years. There are no wells producing both oil and gas commercially, though a few oil wells yield gas enough to pump them.

Petroleum

Crude petroleum in 1917 exceeded the 1916 output by 214,019 Imperial gallons, the production being 7,104,700 gallons, as against 6,890,681 gallons. In price there was a series of advances which brought the value per barrel from $1.98 on January 1 to $2.48 on December 31, the average for the year being $2.34 per barrel. A small decline in the older fields was more than offset by the output of the new field in the Township of Mosa, Middlesex county, which produced 20,998 barrels during the year. This new pool is the most promising one located in recent years, and in the month of October yielded 6,889 barrels, or nearly as much as the best month's output from the Petrolea and Enniskillen field, at present the largest source of oil in Ontario. The oil in Mosa is found at a depth of 390 to 450 feet in the Corniferous limestone, which is also the oil-bearing formation of the older fields. The first strike was made by F. J. Carman on or about February 1, 1917. Up to the end of February, 1918, about 40 producing wells had been drilled, and 13 dry holes. A number of other wells were in process of being drilled. The pool as then located was on lots 5 to 8 in the fifth, sixth, and seventh concessions of the township. In quality the oil is good, the gravity being 33°. Facilities for handling and marketing the oil are satisfactory, tank cars conveying it from the field to the pipe line at Glencoe.

Drilling operations at Rockwood, in the county of Wellington, were not successful in obtaining oil. At Flesherton, Grey county, shows of oil have been found, but no reservoir has been located.

Oil was reported to have been found on the west bank of the Wanapitei river on lots 9 and 10, in the sixth concession of the township of Street, near the crossing of the Canadian Northern railway, and considerable local interest was aroused in the spring and early summer of 1918. An examination was made on behalf of the Bureau by E. S. Estlin, who found the presence of oil to be shown by a fine brilliant film which floated on the water when a shovelful of gravel taken from the bank was thrown into the river. Nearby were the remains of an old lumbering camp abandoned about 20 years ago, and upon clearing away the growth immediately above the gravel bank on the river side traces of a small building were found, the floor area being covered with chips and shavings saturated with what appeared to be ordinary coal oil. This was no doubt the site of the oil-house once connected with the lumber camp and also the source of the oil which showed in the gravel below. A little of the oil was with some pains procured from the floating films, and proved on examination to be coal oil or kerosene.

A comparison of the deliveries of oil from the several producing areas, for the years 1916 and 1917 is as follows, the figures being given in barrels of 35 Imp. gals.:—

PETROLEUM PRODUCTION BY FIELDS.

Field.	1916	1917	Gain	Loss
Lambton	142,208	132,524	....	9,684
Bothwell	33,856	29,682	....	4,174
Dutton	2,851	2,941	90	....
Tilbury	16,296	10,041	....	6,255
Onondaga	1,617	383	....	1,234
Belle River	46	....	....	46
Mosa	....	20,998	20,998	....
Thamesville	....	6,420	6,420	....
Total	196,874	202,989	27,508	21,393

Inspector Scott furnishes the following list showing particulars of the oil wells of Lambton county and vicinity.

OIL WELLS, 1917

Municipality.	Pumped.	Baled.	Not operated.	Abandoned.	Total.
Sarnia township	174	....	42	60	276
Plympton "	30	....	42	21	93
Moore "	155	....	61	55	271
Enniskillen "	2,477	437	896	121	3,931
Oil Springs	1,012	....	63	27	1,002
Bothwell	278	....	....	7	285
Thamesville	15	....	29	6	50
Dawn township	....	....	63	28	91
Euphemia township	56	....	....	22	78
Brooke township	10	....	....	2	12
Dutton	192	....	15	....	207
Mosa township	35	....	....	12	47
Indian Reservation	....	....	11	....	11
Total	4,434	437	1,222	361	6,454

In Essex and Kent counties Inspector Beno reports that two new oil wells were sunk and eight wells abandoned during the year, the total number in operation being 34. This is a reduction of 17 from 1916, when 51 were being worked. The finding of oil in considerable quantity in the well bored for gas on lot 3, in the third concession of Dover West, is significant because of the fact that the oil was obtained in the Trenton limestone and at the great depth of 3,183 feet. The Corniferous formation has heretofore been the source of all Ontario petroleum, but the well in Dover West, notwithstanding the failure of other holes in the vicinity to reproduce its record, affords ground for the hope that deep exploitation of the Trenton, in the southwestern part of the Province, may prove that formation here to be an important reservoir of oil, such as it has proved to be in the northwestern part of the State of Ohio.

Salt

There was again an increase both in the quantity and value of the salt production, the output for 1917 being 138,909 tons, as compared with 128,935 tons in 1916, and the value $1,047,707 as compared with $700,515. The value of the packages is not included. The product was classified as follows:—Coarse, 46,537 tons; fine, 56,028 tons; table and dairy, 34,251 tons; land, 2,093 tons. Included in coarse salt is 14,301 tons, being the equivalent of the brine used by the Canadian Salt Company, Limited, in its chemical plant at Sandwich in the manufacture of caustic soda and bleaching powder. The number of workmen employed in the salt industry was 312, and the wages paid them were $234,925.

There is no salt mined in Ontario, the practice being to pump up the brine, which is then evaporated. Hence all the rock salt sold here for the use of cattle, etc., is imported.

Brunner, Mond Canada, Limited, are erecting a plant at Amherstburg for the manufacture of alkalies. The limestone required will be obtained from the company's quarries about three-quarters of a mile east of the plant, and the brine from its wells on lot 29, in the first concession of Anderdon township, three miles away. It is the company's intention to begin the production of soda ash at the rate of about 100 tons daily, and also at a later date to consider the manufacture of bicarbonates, caustics and chlorides. The works will not be turning out any product until the autumn of 1918.

The list of companies producing salt in 1917 is as follows:—

SALT COMPANIES, 1917.

Name of Owner, Firm or Company.	Location of Wells or Works.	P.O. Address of Manager, etc.
Canadian Salt Company, Limited	Windsor Sandwich	Windsor.
Dominion Salt Company, Limited	Sarnia	Sarnia.
Elarton Salt Works Company, Limited	South of Egremont Road, Warwick tp.	Hyde Park.
Exeter Salt Works Company, Limited	Exeter	Exeter.
North American Chemical Co., Ltd.	Goderich Clinton	Clinton.
Ontario People's Salt and Soda Co., Limited	Kincardine	Kincardine.
Western Canada Flour Mills Company, Limited	Goderich	Goderich.
Western Salt Company, Limited	Mooretown and Courtright	Courtright.
Wingham Salt Works (Alex. Young Estate)	Wingham	Wingham.

Talc

The production of talc continues to increase. In 1915 the shipments were 1,720 tons of crude and 9,285 tons of ground talc; in 1916, 3,665 tons crude and 8,145 tons ground; in 1917, 2,398 tons crude and 13,678 tons ground. The valuation of shipments, including both kinds, in 1915 was $85,325, in 1916 $111,489, and in 1917 $179,554. The talc deposits are situated near Madoc, in the county of Hastings, and the two mills for the grinding and preparation of the mineral are in that town. The latter are operated by Geo. H. Gillespie and Company,

Limited, and Anglo-American Talc Corporation respectively. Botn the crude and ground product are for the greater part exported to the United States.

There were 56 employees engaged in the mining and milling of talc, who received in wages $49,734.

The uses of talc are numerous and important. The properties which are availed of in manufacturing processes are its foliated or fibrous structure, its softness, light colour, lustre, flexibility, unctuous feel, low conductivity and high absorption of heat and electricity. The most important employment of talc is in the manufacture of paper, especially in those varieties used for book and writing purposes. As a filler it not only adds to the weight of the paper, but it imparts whiteness to the colour and renders it opaque, absorptive and capable of taking on a high polish, thus fitting it for lithographing and illustrations. For paper-making, talc is to some extent displacing china clay. It is also used in the manufacture of rubber goods, in sizing and bleaching cotton cloth, in insulator coverings, in soap-making, as a dusting lubricant for shoes and gloves, in cosmetics and toilet preparations, paints, foundry facings, for dressing skins and leather, as a binder in gypsum wall plasters, and in the compact varieties for pencils, "tailors' chalk," and gas tips.

The firms engaged in the talc business were as follows:—

TALC OPERATORS, 1917.

Firm or Company.	Location of Mine or Works.	Address of Manager, etc.
Anglo-American Talc Corporation, Ltd..	Madoc	Madoc.
Cross and Wellington	Huntingdon tp.	Madoc.
*Eldorite, Limited	Eldorado	Eldorado.
Geo. H. Gillespie and Company, Ltd.	Madoc (grinding mill)	Madoc.

* Idle in 1917.

Mining Divisions

The administration of the mining lands of the Province is primarily in the hands of the Recorders for the Mining Divisions in which are comprised the various mineral areas. When a prospector stakes out a claim, he must file his application with the Recorder for the Mining Division in which the land is situated. The Recorder is clothed by the Mining Act with power to settle disputes between the holders of mining claims, and there is a right of appeal from his decision to the Mining Commissioner, and in cases of importance from the latter to the courts of law. There are fifteen mining divisions in the Province, three of which, namely, Timagami Forest Reserve (part), Fort Frances and Eastern Ontario are administered by the Deputy Minister of Mines at the Department in Toronto. Of the others, Coleman Special Mining Division is in charge of the Mining Recorder for the Timiskaming Division at Haileybury, Gowganda under that of the Recorder for Montreal River Division at Elk Lake, and Kowkash under that of the Recorder for Port Arthur Division at Port Arthur.

Following is a statement which shows the collections on account of mining revenue by the several Mining Recorders during the fiscal year ending October 31, 1917:—

RECEIPTS OF MINING DIVISIONS, 1917.

Mining Division.	Name and Address of Recorder	Receipts, 1916-17. Purchase Price.	Permits.	Miner's Licenses.	Recording Fees.	Total.
		$ c.	$ c.	$ c.	$ c.	$ c.
Kenora	W. L. Spry, Kenora	606 40	......	456 00	539 75	1,602 15
Port Arthur	J. W. Morgan, Port Arthur	3,899 07	......	2,464 00	2,899 60	9,262 67
Sault Ste. Marie	W. N. Miller, S.S. Marie	8,306 10	......	837 00	1,194 50	10,337 60
Sudbury	C. A. Campbell, Sudbury	8,937 71	130 00	2,132 00	4,670 45	15,870 16
Timiskaming / Coleman Special	N. J McAulay, Haileybury / " "	4,137 84	50 00	5,314 00	3,651 75	13,153 59
Larder Lake	J. A. Hough, Matheson	23,664 90	......	2,120 00	8,420 75	34,205 65
Gowganda / Montreal River	A. J. Browning, Elk Lake / " "	4,967 80	410 00	922 00	4,554 00	10,853 80
Porcupine	G. H. Gauthier, S. Porcupine	5,205 12	60 00	2,040 15	4,137 10	11,442 37
Parry Sound	H. F. McQuire, Parry Sound	....	......	225 00	303 00	528 00
Kowkash	M. R. Morgan, Tashota	....	120 00	842 00	2,322 50	3,284 50
	Total	59,724 94	770 00	17,352 15	32,693 40	110,540 49

Mr. A. J. Browning died of pneumonia after a week's illness, April 30, 1918, and was succeeded by Mr. H. E. Sheppard, formerly Mining Recorder for Gowganda and Montreal River Divisions, who had returned from overseas service in France and received his discharge. The head office of the Kowkash Division was removed to Port Arthur by Order-in-Council, dated January 28, 1918, and was placed under the charge of Mr. J. W. Morgan, the Recorder for Port Arthur Division. The almost entire cessation of business in Kowkash Division made this step expedient.

Reports from Mining Recorders

In reporting to the Bureau upon the business of the year, the Mining Recorders occasionally remark upon matters of current interest in their several Divisions. Extracts from these reports are appended herewith:—

Kenora.—Claims recorded, 32; cancelled, 16. Mining activity has been less than usual. At the Rognon mines new camps have been built to accommodate more men, and it is the intention to move 600 tons of ore to the mill at the Redeemer mine in Van Horne township for treatment. Southwest of English and near Keewatin lake, the Nicuso syndicate of Ottawa have spent a large amount of money in development work, a diamond drill being in use most of the summer on a deposit of iron pyrites. Just east of Quibell, on the National Transcontinental railway, in the unsurveyed township of Buller, another large deposit of pyrite has been found and several claims recorded. At Northpines the Nichols Chemical Company are doing a big business and employ a large number of men.

Port Arthur.—Claims recorded, 180; cancelled, 59. No new discoveries of much importance have been made in this Division during the year 1917. So many prospectors have joined the army for service in France that little prospecting can be expected until the end of the war.

Sault Ste. Marie.—Claims recorded, 135; cancelled 9. The whole mining division from Michipicoten to Bruce Mines, and as far north as the township of Hayward, has been unusually active. The gold claims near Wawa lake, Michipicoten, which have been lying dormant for many years, are likely to be re-opened and worked by a strong Pittsburg company. In township 49, on the Algoma Central railway, Dan McCarthy, while prospecting for iron pyrites in October, 1917, found a vein of quartz with a spectacular showing of free gold. He and his party staked eight claims, having found free gold on five of them. Other discoveries of free gold have since been made, and claims staked. J. P. Cline, of South Porcupine, made a good discovery of free gold at Pine lake, on the eastern boundary of township 49. The gold occurs in schist between large bodies of pyrite, claims for which have also been staked on the boundary line between townships 49 and 27. Mr. Harry Dreany has had a diamond drill operating on his iron claims, and has located a large body of ore. Gold was discovered in the township of Hayward.

Sudbury.—Claims recorded, 262; cancelled 62.

Timiskaming: Coleman Special.—Claims recorded, 269; cancelled, 75. There was little prospecting in these divisions, except in Rickard township, where a discovery of gold was made by one John Raty, and three claims taken up which were optioned to the Mining Corporation of Canada and are now being developed. Several discoveries were reported from the township of Eby and a number of claims recorded. Very little development work was done, except where necessary to hold new claims, largely because of the general extension of time given on old claims by the Order-in-Council of May 26, 1917. This extension, however, was of material benefit to a number of prospectors. Fewer miner's licenses were issued owing to the number of prospectors who have enlisted and are serving their country overseas.

Larder Lake.—Claims recorded 160. Receipts show an increase over 1916 of nearly $3,000. This division is steadily growing in importance, and during the year 1918 should add to the list several new producing gold mines. Much development work was done, principally at Kirkland Lake, Boston Creek, Skead, Larder Lake and Munro. Several discoveries were made; one of which, near Bourke's, in the township of Benoit, appears to be of exceptional merit. Another, assaying well in gold content, was made in August in the unsurveyed territory south of Lake Abitibi, on the Lightning river. Many of the best prospectors of this division lie buried in France and Flanders.

Gowganda.—Claims recorded, 113; cancelled, 80. The chief staking was around the O'Brien mine, in Nicol and Haultain, and around Reeve-Dobie, in Milner. The following properties have been worked: O'Brien mine, Castle, Welsh claims, T.C. 177, Collins on Leroy lake, Mining Corporation of Canada on Hylands claims, all in Nicol Township; Crews-McFarlan, Reeve-Dobie, Silverado, in Milner.

Montreal River.—Claims recorded, 294; cancelled, 147. A considerable amount of prospecting was done, and the receipts were two and a half times as much as in 1916. This was due chiefly to the staking in Powell, Cairo, and Yarrow townships, owing to the discovery of gold on the McKay-Davidson and

Otisse claims. A road has been cut from a point on the Montreal river above Indian Chutes so as to enable machinery to be placed on the properties. Mining was done in Auld township on Kenabeek mines, in Cane on Quesnell claims, in Mickle at the Brant mines (old Mapes-Johnston), and at White Reserve in Maple Mountain area, also some work at McKenzie lake in Speight. Lieut. Skill, long Recorder of this division, was killed in action somewhere in France in 1917.

Porcupine.—Claims recorded, 236; cancelled, 160. There was a considerable falling off in receipts, directly attributable to the extensions granted for assessment work to men serving overseas, and to other claim-holders on account of war conditions. There have been no new finds afield. Prospecting and staking were confined to claims as they became open in the older portions of the camp. The numerous extensions of time have kept most of the claims in good standing and put an end to activity for the time being. The showing maintained by the producing mines in 1917, in spite of the shortage of labour and largely increased cost of production due to war conditions, was most gratifying.

Parry Sound.—Claims recorded, 25. Some mica claims in McConkey township were sold to Detroit parties who are preparing to work them during the summer of 1918. Some feldspar claims have changed hands, also the Parry Sound Copper Mining Company's holdings near Parry Sound, where the new owner did some diamond drilling.

Kowkash.—Claims recorded, 135; cancelled, 69. During the first nine months business was good, but winter set in about October 1 and all mining and prospecting came to an end, the Wells property having been closed down.

Mining Companies

Mining companies incorporated under the laws of Ontario numbered 100 in 1917, with an authorized capitalization of $117,183,000, as against 83, with a nominal capital of $109,075,500, in 1916. There were seven companies of foreign incorporation licensed to do business in the Province, and to employ capital amounting in the aggregate to $7,202,000.

The lists follow:—

MINING COMPANIES INCORPORATED IN 1917.

Name of Company.	Head Office.	Date of Incorporation.	Capital.
Algoma Exploration & Development Co., Ltd.	Sault Ste. Marie	Aug. 29	$40,000
Alloy Steel Works, Limited	Toronto	Oct. 15	2,000,000
Anglo-Kirkland Gold Mines, Limited	Haileybury	Mar. 17	500,000
Asquith Gold Mining Company, Limited	Toronto	Oct. 9	2,000,000
Atlas Gas & Oil Company, Limited	Toronto	April 3	300,000
Baldwin Gold Mining Company, Limited	Toronto	Feb. 13	2,500,000
Bellinger-Porcupine Mines, Limited	Toronto	Mar. 2	2,000,000
Big Duck Lake Mining Company, Limited	Ottawa	July 14	30,000
Bolton Mining Company, Limited	Windsor	Jan. 4	500,000
Bourkes Mines, Limited	Toronto	July 21	2,500,000
Brant Mines, Limited	Brantford	Sept. 1	1,500,000
Buffalo Kirkland Mines, Limited	Toronto	Mar. 21	1,500,000

MINING COMPANIES INCORPORATED IN 1917.—*Continued.*

Name of Company.	Head Office.	Date of Incorporation	Capital.
Bungalow Brick Company, Limited	Toronto	April 3	40,000
Canadian Oil Fields, Limited	Brantford	Jan. 9	500,000
Cane Silver Mines, Limited	Toronto	Oct. 12	1,500,000
Castle Mining Company, Limited	Toronto	Sept. 7	1,500,000
Chaput-Hughes Gold Mines, Limited	Toronto	April 11	2,000,000
Colossus Gold Mines, Limited	Toronto	Jan. 19	2,000,000
Continental Development Company, Limited	Toronto	Feb. 12	250,000
Consolidated Metals Corporation, Limited	Toronto	Oct. 17	3,000,000
Crœsus Lake Gold Mines, Limited	Toronto	Aug. 1	1,000,000
Crystal Products, Limited	Toronto	Sept. 26	300,000
Delta Chemical Company, Limited	Toronto	Aug. 15	40,000
Dominion Kirkland Gold Mines, Limited	Toronto	Oct. 6	2,000,000
Dominion Mica Mining Company, Limited	Toronto	April 2	50,000
Dominion Molybdenites, Limited	Toronto	May 2	1,000,000
Eastern Mining and Milling Company, Limited	Toronto	Sept. 1	500,000
East Kirk Mining Company, Limited	Toronto	Jan. 20	2,500,000
Feldspar Milling Company, Limited	Toronto	May 3	50,000
Feldspar Quarries, Limited	Toronto	Feb. 15	40,000
Fidelity Mining & Development Co., Limited	Haileybury	May 14	2,000,000
Fisher Gold Mining and Milling Co., Limited	Toronto	June 5	2,500,000
Flesherton Oil Fields, Limited	Windsor	Aug. 27	500,000
Galt Building Products, Limited	Galt	May 7	40,000
Gold Banner Mines, Limited	Toronto	Sept. 21	2,000,000
Graham Development & Contracting Co., Ltd.	Fort William	July 23	100.000
Howrey Creek Mining Corporation, Limited	Toronto	Dec. 7	1,000,000
Kent County Oil, Gas and Coal Co., Limited	Windsor	Dec. 19	40,000
Kerr Lake Mines, Limited	Cobalt	Oct. 13	3,000,000
Kirkland Combined Mines, Limited	Toronto	May 28	2,000,000
Kirkland-Porphyry Gold Mines, Limited	Haileybury	Aug. 3	3,000,000
Kirkland-Townsite Gold Mines, Limited	Haileybury	Mar. 15	2,000,000
Lucky Cross Bondholders, Limited	Toronto	Sept. 14	100,000
McConnell Consolidated Mines, Limited	Toronto	April 16	1,000,000
McEnaney Gold Mines, Limited	Toronto	June 30	3,000,000
McGinley-Teck Gold Mines, Limited	Haileybury	April 27	2,000,000
Macassa Gold Mines, Limited	Toronto	Feb. 10	2,000,000
Mineral Products, Limited	Madoc	Feb. 2	100,000
Nickel Lake Mining Company, Limited	Fort Frances	Dec. 10	1,000,000
Nipissing Mines Company, Limited	Toronto	June 28	6,000,000
North Davidson Mines, Limited	Toronto	Mar. 30	2,000.000
Ontario-Kirkland Gold Mines, Limited	Haileybury	Sept. 18	1,500,000
Ontario Molybdenum Company, Limited	Toronto	April 17	40.000
Oxford Lime Products, Limited	Woodstock	April 13	40,000
Paragon-Hitchcock Mines, Limited	Collingwood	May 22	2,000,000
Paudash Lake Molybdenite Mines, Limited	Wilberforce	Nov. 13	150,000
Penn Porcupine Mining Co., Limited	Toronto	Feb. 2	3,000,000
Pontiac Molybdenite Company, Limited	Toronto	May 12	500,000
Porcupine Whelpdale Mines, Limited	Toronto	Sept. 13	2,500,000
Rand Consolidated Mines, Limited	Toronto	July 12	5,000,000
R.A.P. Gold Mining Co., of Boston Creek, Ltd.	Toronto	Jan. 29	2,500,000
Reeve-Dobie Mines, Limited	Toronto	May 4	2,000,000
Rockwood Oil and Gas Company, Limited	Toronto	Oct. 9	1,000,000
Rominco Mines Company, Limited	Toronto	Mar. 12	10,000
Bypan Porcupine Mines, Limited	Toronto	Jan. 23	2.000,000
St. Luke's Oil and Gas Company, Limited	Toronto	July 24	2,000,000
Sarvice, Limited	Chatham	July 9	48,000
Sesekinika Lake Gold Mines, Limited	Toronto	Jan. 18	2,000,000
Standard Gravel Company, Limited	Niagara Falls	Feb. 24	40,000
T.C. 177 Mining Company, Limited	Gowganda	Mar. 10	40,000
Thackeray Mines, Limited	Toronto	April 19	2,000,000
The Battle Natural Gas Company, Limited	Hamilton	Oct. 11	100,000
The Cascade Lead-Silver Mines, Limited	Toronto	May 9	1.000.000
The Duck Lake Mining Company, Limited	Fort William	Dec. 26	250.000

MINING COMPANIES INCORPORATED IN 1917.—*Continued.*

Name of Company.	Head Office.	Date of Incorporation	Capital.
The Glenn-Clayton Mining Company, Limited..	Toronto	Mar. 2.....	1,000.000
The Goldore Mining Corporation Limited	Toronto	Feb. 17.....	40.000
The Great West Chemical Corporation, Limited	Port Arthur	Oct. 31.....	1,500,000
The Hennepin Mining Company, Limited	Port Arthur	Feb. 20.....	40,000
The Hope Exploration Co. of Canada, Limited	Niagara Falls ..	Feb. 6.....	100,000
The Indian Trail Mines, Limited	Toronto	Nov. 15.....	1,000,000
The London Smelting and Refining Co., Ltd...	London	Mar. 14.....	45,000
The Maple Leaf Exploration Company, Limited	Toronto	Sept. 22.....	40,000
The Merlin Oil and Gas Company, Limited	Merlin	April 26.....	40.000
The Mining Investors' Corporation, Limited ..	Toronto	Sept. 19.....	40,000
The National Potash Corporation, Limited	Toronto	April 30.....	1,500,000
The Progressive Gas and Oil Co., Limited	Hamilton	Aug. 18.....	1,000.000
The St. Clair Oil and Gas Corporation, Limited	Toronto	Jan. 30.....	3,000,000
The Shining Tree Mining and Milling Co., Ltd.	Sudbury	April 13.....	500,000
The Tilbury Brick and Tile Company, Limited	Tilbury	Feb. 15.....	40,000
The Tory Hill Marble and Mica Co., Limited..	Toronto	Mar. 21.....	100,000
The Velvet Mining Company, Limited	Windsor	Mar. 12.....	40,000
The Walkerville Brick and Tile Co., Ltd.	Walkerville	Oct. 31.....	40,000
Trenton Gas & Oil Company, Limited	Toronto	Aug. 9.....	40,000
Union Cement, Limited	Owen Sound ...	May 4.....	1,000.000
United Kirkland Gold Mines, Limited	Haileybury	May 10.....	2,000,000
Vandorf Brick Works, Limited	Toronto	Oct. 5.....	40,000
Warco Oil and Gas Company, Limited	Brantford	Sept. 6.....	300,000
Wasapika Gold Mines, Limited	Toronto	June 7.....	1,000,000
Wisconsin-Skead Mines, Limited	Haileybury	Aug. 27.....	2,000,000
Wright-Porcupine Mines, Limited	Haileybury	Jan. 30.....	2,000,000
		Total.....	$117,183,000

MINING COMPANIES LICENSED IN 1917.

Name of Company.	Head Office for Ontario.	Date of License.	Capital for use in Ontario.
Electric Steel & Engineering, Limited	Welland	July 18.....	$2,000,000
McLaurin Mining Company	Port Arthur	Feb. 8.....	50,000
National Abrasive Company	Toronto	May 18.....	60,000
Ontario Petroleum Co.	Bothwell	Nov. 20.....	40,000
Ontario Western Mining Company, Limited ...	Cobalt	June 7.....	12,000
The International Nickel Co. of Canada, Ltd..	Toronto	Jan. 6.....	5,000,000
The Solvay Process Company	Toronto	Mar. 31.....	40,000
		Total	$7.202,000

Mining Revenue

Sources of Government revenue are the following: Sales and leases of mining lands, miners' licenses, recording and other fees under the Mining Act, royalties on sand and gravel, and taxes levied under the Mining Tax Act, namely, on mining profits, mining lands, and natural gas. Of these the tax on profits is the most considerable. The Act puts a tax of 3 per cent. on the net profits of mining companies up to $1,000,000, and a graded rate beginning at 5 per cent. on profits in excess of this amount, the first $10,000 of profits being exempt. An exception is made of nickel-copper mining concerns, whose rate is graded from 5 per cent. upward, and is computed on the selling price of the refined products less the cost of production.

The revenue for the fiscal year ending October 31, 1917, was as follows:—

Sales of mining land	$57,054 50
Mining leases	16,845 01
Miner's licenses, recording fees, etc.	62,256 41
Sand and gravel royalties	28,372 93
Mining Tax Act	1,557,543 37
Provincial Assay Office	726 52
Miscellaneous	31 50
Total	$1,722,830 24

Sales and Rentals.—Mining lands are sold at $2.50 per acre in the unsurveyed territory, where the purchaser is obliged to procure a survey at his own expense, or $3.00 per acre in the surveyed lands which have been laid out by the Government. In Forest Reserves, mining lands are disposed of only by lease for a period of ten years, renewable at option of the lessee. The following table of mining lands sold and leased gives the particulars for the fiscal year. The receipts do not quite agree with those given in the above summary, since the latter comprises all sums received, while in the table is included only sales and leases actually completed within the year.

MINING LANDS SOLD AND LEASED, 1917.

District.	Sales.			Leases.			Total.		
	No.	Acres.	Amount.	No.	Acres.	Amount.	No.	Acres.	Amount.
			$ c.			$ c.			$ c.
Timiskaming	359	12,496.52	33,382 39	93	3,292.75	3,052 90	452	15,789.27	36,435 29
Thunder Bay	37	1,398.97	3,258 69	3	120.00	120 00	40	1,518.97	3,378 69
Algoma	47	2,796.44	7,031 16	....	....	....	47	2,796.44	7,031 16
Sudbury	57	2,251.62	6,732 28	43	1,549.54	1,549 54	100	3,801.16	8,281 82
Nipissing	5	263.42	602 75	....	....	....	5	263.42	602 75
Kenora	7	260.30	590 75	....	....	....	7	260.30	590 75
Elsewhere	14	687.04	1,387 62	....	....	....	14	687.04	1,387 62
Total	526	20,154.31	52,985 64	139	4,962.29	4,722 44	665	25,116.60	57,708 08

Miner's Licenses, Recording Fees, etc.—For a miner's license entitling the holder to stake out mining claims on Crown lands a fee of $5 is fixed by the Mining Act. A license is good until March 31 next after the date of issue, and may be renewed on or before April 1 at a like cost. A license issued after October 1 costs $3 only. A permit to prospect for minerals in a Forest Reserve costs $10, and is good for twelve months. The fee for recording a mining claim is $10.

Sand and Gravel Royalties.—As already stated, licenses may be issued for the removal of sand and gravel from Crown lands on payment of a royalty charge varying from three to twelve cents per cubic yard. These lands are for the most part those covered by the waters of the great lakes or boundary rivers.

Mining Tax Act.—Revenue is derived from three sources, the receipts for the fiscal year being as follows:—

Acreage tax	$14,347 99
Profit tax	1,503,967 62
Natural gas tax	39,227 76
Total	$1,557,543 37

In 1916 the receipts were $186,827.12.

By amendment to the Mining Tax Act passed at the session of 1917, the tax on mining lands was increased from two to five cents per acre, and it was made applicable to mining land wherever situated, instead of to areas only without county organization, as formerly. The higher rate may be expected to produce a somewhat larger revenue.

An explanation has already been given of the changes made in the Mining Tax Act, so far as the profit tax is concerned. Following is a statement, classified according to products, of the mining companies who paid the profit tax and the respective amounts paid during the last fiscal year:—

Gold:		
Porcupine Crown Mines, Limited	$3,771 50	
The Dome Mines Company, Limited	7,597 46	
McIntyre-Porcupine Mines, Limited	4,195 54	
		$15,564 50
Silver:		
The Mining Corporation of Canada, Limited	$10,494 55	
Seneca-Superior Silver Mines, Limited	6,640 20	
Nipissing Mining Company, Limited	40,358 44	
Cobalt Comet Mines, Limited	288 45	
Kerr Lake Mining Company, Limited	14,393 25	
Crown Reserve Mining Company, Limited	184 74	
McKinley-Darragh-Savage Mines of Cobalt, Limited	3,883 95	
Penn-Canadian Mines, Limited	207 50	
La Rose Mines, Limited	3,328 56	
Timiskaming Mining Company, Limited	2,766 46	
The Coniagas Mines, Limited	9,811 27	
M. J. O'Brien	5,682 09	
Casey Cobalt Silver Mining Company, Limited	1,134 28	
		99,173 74
Pyrite:		
Northern Pyrites Company	$715 60	
The Nichols Chemical Company, Limited	498 57	
		1.214 17
Nickel-Copper:		
Alexo Mining Company, Limited	$468 87	
The Mond Nickel Company, Limited	20,000 00	
The Canadian Copper Company, 1916	530,110 00	
The Canadian Copper Company, 1917	836,782 00	
		1,387,360 87
Miscellaneous:		
Algoma Steel Corporation (Iron)	$135 48	
Cross and Wellington (Talc)	5 72	
Black Donald Graphite Company, Limited (Graphite)	513 14	
		654 34
Total		$1,503,967 62

It should be added that the taxes under the Mining Tax Act are payable on or before October 1. Occasionally there is some delay in adjusting or remitting the amount, and payment may not be actually made until after the close of the financial year, which ends with October. This will account for the absence of one or two mining companies from the above list, which includes only those who paid within the fiscal year.

Operation of the Mining Tax Act in 1917

Mr. G. R. Mickle, Mine Assessor, makes the following comments:—

Under this Act three taxes are levied, viz.: (1) the Profit Tax, being on the profits made by the different mining companies computed as outlined in the Act with certain deductions for taxes paid municipalities; (2) the Natural Gas Tax, being a fixed amount of two-tenths of a cent per thousand cubic feet; and (3) the Acreage Tax of five cents per acre on all mining lands. The total amount paid in respect of these taxes for 1917 amounted to $1,643,847.39, and the distribution is as follows:—

Profit Tax	$1,583,864 07
Natural Gas Tax	36,057 90
Acreage Tax (15th April, 1917, to 15th April, 1918)	23,925 42
Total	$1,643,847 39

These amounts given above are the taxes belonging to 1917 which are not due till Oct. 1st, and consequently some of them are not paid before the end of the fiscal year for the Province, Oct. 31st. This statement, therefore, will not agree with the Public Accounts.

Of this amount $555,879.12 was tax for 1916 on nickel mines which was not collected or determined in 1916, as the Act was entirely altered with respect to nickel and nickel-copper mines. Any comparison with past years is of no value under these circumstances. Of the total amount collected as profit tax, nickel mines contributed $1,413,129.99; silver mines, $94,606.29; gold mines, $75,215.51; and miscellaneous mines, $902.28.

The natural gas tax was about 20 per cent. more than was collected last year. Unless important new fields are found there must be a decline of revenue from this source, since the output is being restricted as explained elsewhere in this Report.

The acreage tax is the largest collected in any year, due to the increase of the tax from two to five cents per acre. It is too soon to judge yet what the effect of this change will be. According to the average rate of collection per year of the two cent tax, about 15 per cent. of the lands are in arrears for the 1917 tax; whether this means that the owners of these lands intend to let the title lapse or are merely taking breath, will be known in a year or so.

Provincial Assay Office

W. K. McNeill, Provincial Assayer, reports as follows for the year 1917:—

To an increased demand for minerals occasioned by war conditions, probably, was due to a great extent the increase in the work of this Office for the year. The Assay Office was utilized more than ever by those interested in the mining industry, and apart from actual assaying of ores and mineral products, a great deal of general information and advice was given, for which no fee was charged.

During the year the equipment was augmented by a Brown crusher and pulverizer and a Caso gas assay furnace.

The work, as in former years, may be classified as follows:

1. Examination and assaying of samples for prospectors, mining engineers, geologists, and the public generally. For this work the Department charges the regular fee.
2. Analyses of samples of rocks, etc., for the geologists of the Bureau of Mines.
3. The sampling of car lots of Cobalt silver ores shipped from the mines, upon which the government collects a royalty. This work is in charge of Mr. T. E. Rothwell, Assistant Assayer.
4. The assaying and valuation of these car lots.
5. Assaying of the products of the Cobalt silver ores, for which the government gives a bounty.
6. Special research work.

The work may be further classified as follows:

Gold and Silver Assays.—803 samples were submitted for gold and silver, including car lots, each car being represented by one sample.

Platinum minerals.—15 samples were submitted for platinum minerals. These were also tested for palladium, iridium and other allied metals.

Copper ore.—57 samples were analysed for copper. These were mostly from Ontario, although a few were sent from the province of Quebec.

Nickel and Cobalt ores.—51 samples were tested for nickel and cobalt.

Iron ores.—15 samples were analysed for iron, sulphur and phosphorus.

Molybdenum ores.—39 samples, mainly concentrates, were received and reported upon.

Zinc and Lead ores.—23 samples were analysed for the zinc and lead content.

Rock analyses.—14 rock samples were submitted by the Provincial Geologist for complete analysis.

Limestones.—79 samples were submitted; of these 14 were for complete analysis, the others for magnesia content.

Identification.—96 samples were submitted by mail and reports issued. In addition, some hundreds of samples were brought directly to the office and identified. No charge is made for this work.

Miscellaneous.—60 samples were submitted. Under this heading are included barite, fluorspar, manganese, chromium, etc.

The work of the Department is carried on with the assistance of T. E. Rothwell, Assistant Assayer, and A. T. Leat, who is employed as a sampler and general assistant.

Samples sent in by the public will be dealt with in the order of their arrival. In every instance specimens and samples should be accompanied by statement specifying the precise locality from which they were taken.

Crushed samples representing large quantities or samples less than five pounds weight may be sent by mail as third class matter. Write name and address plainly on each parcel. Send instructions, with money in payment of fees in a separate letter. Samples may be sent by express, charges prepaid.

Sample bags addressed to the Laboratory for sending ore pulp by mail may be obtained free on application; also canvas bags for shipping.

Money in payment of fees, sent in by registered letter, post-office order, postal note, or express order, and made payable to the Provincial Assayer, must invariably accompany sample to insure prompt return of certificate, as no examination is commenced until the regulation fee is paid.

Samples addressed as follows: "To Provincial Assay Office, 5 Queen's Park, Toronto, Ont."

The following schedule of fees is as revised, and took effect June 1st, 1918:

TARIFF OF FEES FOR ANALYSES AND ASSAYS

1. Assays:

Gold	$1 50
Silver	1 50
Gold and Silver in one sample	2 50
Platinum Minerals	5 00
Gold and Platinum Minerals in one sample	7 00
Separation of Platinum Minerals	Prices on application.

2. Iron Ores:

Iron (metallic)	$1 50
Silica	1 50
Iron and Insoluble residue	2 50
Ferrous Oxide	2 00
Phosphorus	3 00
Sulphur	2 50
Iron, Sulphur, Phosphorus and insoluble	8 00
Manganese	3 00
Titanium	4 00
Complete analysis	Price on application.

3. Limestones, Dolomites, Marls, Clays, Shales:

Determination of:

Insolubles	$1 50
Silica	1 50
Ferric Iron	3 00
Ferrous Iron	2 00
Alumina	3 00
Lime	2 00
Magnesia	2 50
Potash	5 00
Soda	5 00
Alkalies (on one sample)	6 00
Water (combined)	2 00
Moisture	1 00
Carbon Dioxide	2 00
Sulphur	2 50
Phosphorus Anhydride	3 00

4. *Examination of Clay, Shale, or Cement Rock for Cement Manufacture:*
Determination of:
Silica, Iron Oxide, Alumina, Lime, Magnesia, Sulphur, and Volatile matter.
Prices on application.

5. *Coal, Coke, Peat, Etc.:*
Determination of:

Moisture	$1 00
Volatile Combustible	1 50
Fixed Carbon	1 50
Ash	1 50
Sulphur	2 50
Phosphorus	3 00
Calorific value (B.T.U.)	5 00
Ultimate analysis	Price on application.

6. *Mineral Waters* .... Price on application.

7. *Ores and Minerals:*

Determination of:

Alumina	$3 00
Antimony	4 00
Arsenic	4 00
Bismuth	4 00
Cadmium	4 00
Chromium	5 00
Cobalt	5 00
Nickel	5 00
Cobalt and Nickel on same sample	6 00
Copper	2 00
Fluorite	4 00
Lead	3 00
Molybdenum	4 00
Manganese	3 00
Tin	4 00
Zinc	3 00

8. *Rocks, Complete Analysis* .... Price on application.

9. *Slags, Sand, Etc.* .... Price on application.

10. *Identification of Minerals and Rocks not requiring Chemical Analysis*... Free.

11. *Test for Radio-Activity* .... Free.

Any analytical work not specified in this circular will be undertaken on application to the Provincial Assayer.

The pulp of each sample is retained for future reference.

MINING ACCIDENTS IN 1917

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, E. A. Collins, Cobalt; J. H. Stovel, Sudbury

During the year 1917 at the mines, metallurgical works, quarries, clay and gravel pits regulated by the Mining Act of Ontario there were 34 fatal accidents causing the death of 36 men, as compared with 51 deaths in 1916. Of these, 18 accidents resulting in 19 deaths occurred underground. Seven men were killed above ground at the mines, six at the metallurgical works, and four at the quarries.

Seventeen companies had fatal accidents during the year.

Table of Fatalities

	1916	1917
Mines, underground	30	19
Mines, surface	7	7
Metallurgical works	8	6
Quarries	6	4
Total	51	36

The fatalities at the mines were divided amongst the several districts as follows:

	1916	1917
Gold mines of Porcupine and Kirkland Lake	14	8
Silver mines of Cobalt and adjacent districts	8	9
Nickel-copper mines of Sudbury	13	9
Iron mines of Michipicoten	2	0
Total	37	26

By months the fatalities occurred as follows:

	1916	1917
January	7	8
February	4	3
March	1	2
April	2	3
May	7	2
June	5	0
July	1	5
August	2	6
September	3	1
October	1	3
November	10	0
December	8	3
Total	51	36

Analysis of Fatalities at Mines

Cause:—	1916 Per cent.	1917 Per cent.
Falls of ground	24.3	15.4
Shaft accidents	27.0	15.4
Explosives	21.6	15.4
Miscellaneous underground	8.1	26.9
Surface	18.9	26.9

Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1917

—	Persons killed at metallurgical works and mines.	Persons employed at metallurgical works and producing mines.	Persons employed at non-producing mines (estimated).	Total persons employed.	Fatal accidents per 1,000 employed.
1901........	13	4,135	550	4,685	2.77
1902........	10	4,426	450	4,876	2.05
1903........	7	3,499	400	3,899	1.79
1904........	7	3,475	400	3,875	1.80
1905........	9	4,415	500	4,915	1.83
1906........	11	5,017	750	5,767	1.90
1907........	22	6,305	1,140	7,445	2.93
1908........	47	7,435	1,750	9,185	5.11
1909........	49	8,505	2,000	10,505	4.66
1910........	48	10,862	2,000	12,862	3.73
1911........	49	12,543	2,000	14,543	3.37
1912........	43	13,108	2,000	15,108	2.84
1913........	64	14,293	2,000	16,293	3.93
1914........	58	14,361	1,500	15,861	3.60
1915........	22	13,114	1,500	14,614	1.51
1916........	51	14,624	2,000	16,624	3.07
1917........	36	16,791	1,000	17,791	2.02
Total.......	546	156,908	21,940	178,848	3.05

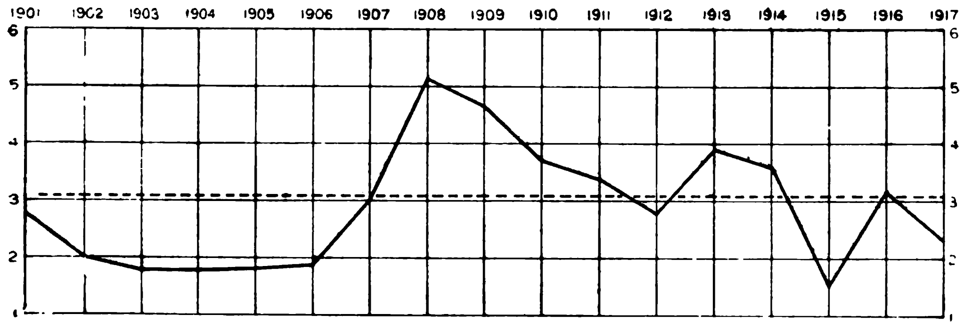


Diagram showing Mining Fatalities per thousand men employed between the years 1901-1917. The dotted line represents the average for the period.

The occupation and nationality of the men killed are set out in the following table:

Occupation.	English-speaking.	Austrian.	Finn.	Bulgarian.	Russian.	German.	Italian.	Total.
Machine runner......	3	2	1	....	1	.....	....	7
Trammer............	1	3	....	....	1	.....	1	6
Machine helper	3	....	2	....	....	.....	....	5
Labourer	2	1	....	....	....	.....	....	3
Foreman	2	....	....	....	....	.....	....	2
Blockholer	....	....	....	1	....	1	....	2
Hoistman	2	....	....	....	....	.....	....	2
Chute blaster	....	....	....	1	....	.....	....	1
Timberman	1	....	....	....	....	.....	....	1
Millman	1	....	....	....	....	.....	....	1
Mechanic	1	....	....	....	....	.....	....	1
Teamster............	1	....	....	....	....	.....	....	1
Engineer	1	....	....	....	....	.....	....	1
Stovetender..........	1	....	....	....	....	.....	....	1
Coal dryer	1	....	....	....	....	.....	....	1
Ladleman............	....	1	....	....	....	.....	....	1
Total,...........	20	7	3	2	2	1	1	36

The ages of the men killed were as follows:

17–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	Total.
2	7	10	4	5	4	1	1	2	36

Cause and Place of Fatalities in Mines

Below Ground:—
- Falls of ground 4

Shaft Accidents:—
- Falling from skip 1
- Struck by objects falling down shaft 1
- Falling down shaft 2

Explosive Accidents:—
- Walked into blast 2
- Premature explosion while lighting holes 1
- Remaining in vicinity of blast and struck by rock 1

Miscellaneous Accidents:—
- Falling down raise 1
- Falling down ore pass 1
- Rock rolling down stope 1
- Ore falling from chute 1
- Crushed between car and chute 1
- Timber falling down raise 1
- Stull breaking 1

Above Ground:—
- Struck by loaded skip (ore transportation) 1
- Slipped under moving locomotive (ore transportation) 1
- Slide of lumber from loaded car 1
- Caught by counterweight cable 1
- Wound around pulley in mill 1
- Kicked by horse 1
- Falling down rock dump 1

Metallurgical Plants:—

Asphyxiation	1
Burned by hot gases	1
Ran over by railroad car in yard	1
Struck by ladle	1
Fall from oiling platform	1
Crushed between passenger coach and platform	1

Quarries:—

Explosion in magazine	2
Caught in conveyor belt	1
Fall of rock from face	1

Falls of Ground

This was formerly a prolific cause of fatal accidents, particularly in the larger mines of the Province. Due to more efficient scaling methods, fatalities from this cause have been greatly reduced. During the year 1917 four men were killed by falling ground, three in Cobalt and one in Sudbury. At the Trethewey mine, April 17th, two shovellers were warned away from dangerous ground by the shift boss. While attempting to leave the stope one man fell into the open top of the chute into which they were shovelling, and was struck by the rock rolling down the stope. He died from his injuries April 22nd.

At the Nipissing Fourth of July shaft on January 12th two men were struck by falling ground while scaling in a winze. The shift boss had ordered two machine crews to scale the walls of the winze carefully. The corner of the winze where the fall occurred had been scaled with picks, but a scaling bar or gad was not used. One of the helpers, David, was instantly killed and his partner, Lauzon, received serious injuries, and died from pneumonia a few days later. This was evidently a case of bad judgment on the part of the machine men who did the scaling. The ground was bad, but there was no reason why it could not have been properly scaled and made safe.

At the Creighton mine, on March 12th, a blockholer, Joseph Durat, was struck by a small piece of rock which fell from the back of stope 15, tenth level. Scaling was in progress at the time, and Durat, without any apparent reason, walked under the unscaled portion towards the manway. He received severe injuries in the region of the thigh and backbone, resulting in death March 16th.

Shaft Accidents

Four men were killed in shaft accidents during the year. At the Sylvanite mine, April 10th, an Austrian fell about twenty-five feet from a set of timbers to the bottom of the shaft. This accident was due to carelessness in using 7/8-inch instead of 3/4-inch nuts on 3/4-inch hanging rods, allowing wall plate to drop down.

Harry Yates, a Canadian, fell down the shaft from the third to the fifth level of the Levack mine, April 19th. Yates was employed as underground hoistman and had stepped out on a plank to shake the cable and attract the attention of the men below. In returning to the station he in some manner slipped from the plank and fell to the bottom.

Dalton Boomer was killed at the Jupiter shaft, McIntyre mines, on August 22nd. Boomer was one of a sinking crew and had returned to the bottom after

personally cleaning down the last three sets after a blast. He was an exceptionally careful miner, but in some way a small block of timber, used for wedging wall plates, had been loosely placed behind the lagging, and became dislodged when the crosshead struck the stop blocks.

At the McKinley-Darragh mine, on September 29th, a Russian was knocked from the skip at the loading pocket at the 300-foot level and fell to the 400-foot station.

Accidents from Explosives

Four fatalities underground, due to explosives, occurred in 1917. This is a reduction over previous years, due to greater care in the handling and storage of explosives, reporting of missed holes, etc. The Dome Lake accident on May 16th could probably have been prevented had the shift boss sent a helper with the young Austrian, who was killed, to assist in loading and firing the rounds.

The Bulgarian blockholer at the Creighton mine, on May 30th, prepared three sand blasts, waited for two to explode, and walked into the third blast.

The Hollinger accident, on August 31st, was due to the inexperience of deceased, who remained in a ladderway a short distance from a pop shot he had placed and lighted himself.

At the Crean Hill mine, on December 4th, an Austrian miner walked into a blast on the 528 sub-level. All approaches were guarded, and deceased had been warned with the other men, and how he got back to the face unnoticed is unknown.

Miscellaneous Accidents Underground

Seven fatalities, or 36.8 per cent. of the total accidents underground in 1917, may be classified under this heading. Four of these occurred in the large nickel mines of the Sudbury district, one at the Coniagas, one at the Teck-Hughes, and one at the Hollinger. Ore falling from chute, and being crushed between car and chute, accounted for two at the Creighton. The Crean Hill accident, on October 3rd, was due entirely to the use of a grab hook with a chain sling in lowering material, and this should be universally forbidden.

The Coniagas accident, on August 25th, was due to a stull breaking and permitting workman, who was crossing over an abandoned stope, to fall to the ore below, a distance of twenty-five feet. This timber had been in place two or three years and showed no signs of decay.

A second accident due to improper fastening of material when hoisting in a raise caused the death of a miner at the Crean Hill mine on January 2nd.

Falling down an ore pass at the Acme mine, of the Hollinger Consolidated Gold Mines, caused a fatality on December 11th, and at the Teck-Hughes, Kirkland Lake, a Finn named Hemmi, was struck by a large piece of ore rolling down the stope, receiving injuries which resulted fatally September 26th, six weeks after the accident.

Surface Accidents

Seven men were killed in surface accidents at the mines, six at metallurgical plants, and four at quarries during the year, making a total of seventeen fatalities on surface, as compared with nineteen underground, where it might be assumed

that the risk was considerably greater. At the mines the causes were various, only two being due to transportation. At the Hollinger, on October 20th, a workman stepped in front of a loaded skip on the tramway from the Central shaft to the mill; and at the Miller-Lake O'Brien the driver in charge of the small locomotive accidentally slipped under the front trucks and received injuries which resulted fatally.

A rather peculiar accident occurred at the Casey-Cobalt, where the hoistman was killed December 7th. The counterweight stuck in the guides and allowed the counterweight cable to slack down on the ground when the hoist was started. The hoistman was evidently stooping over the cable when the weight fell and threw him into the air. It is obvious that he should have reversed his engine and taken up the slack before leaving the engine room.

Other accidents on surface occurred; the causes were of the usual nature.

At the smelters and blast furnaces only one death occurred from asphyxiation, which is a very good showing. Railway cars in the yards accounted for two fatalities.

Two quarries furnished four fatalities, or 23.5 per cent. of the total surface accidents.

At the Bruce Mines trap rock quarry, on June 25th, two men were killed by an explosion of five cases of dynamite which were stored in an old shed near the working face. The cause of the explosion is unknown, but it is apparent that the accident would not have occurred had the magazine been removed to a proper distance from the quarry.

At the Dominion mines and quarries, at East Neebish, two fatal accidents occurred, one by fall of rock from the face, August 7th, and the other on June 29th, when an Austrian workman was caught in a conveyor belt.

Prosecutions

John Osmak, an Austrian, employed at the Garson mine of the Mond Nickel Company, was sentenced to three months in gaol at Sudbury on April 15th last for tampering with the bell signals in the Garson main shaft.

Table of Fatal Accidents in

No.	Date 1917	Name of Mine.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
1	July 30	Baldwin	Baldwin Gold Mining Co.	Stephen Powers ..	Foreman .....
2	Jan. 2	Crean Hill	Canadian Copper Co. ..	Anti Tainen	Machine helper.
3	Mar. 12	Creighton	do do ..	Joseph Durak ...	Blockholer ....
4	May 30	do	do do ..	Simeon Michaleff.	do ....
5	July 12	do	do do ..	C. Nicholoff	Chute blaster .
6	July 24	do	do do ..	M. Storazuk	Trammer .....
7	Oct. 3	Crean Hill	do do ..	J. Chirkoski	Timberman ...
8	Dec. 4	do	do do ..	M. Bilinski	Trammer .....
9	Dec. 9	Casey Cobalt	Casey Cobalt Silver Mining Co.	H. Patriquin	Hoistman .....
10	Aug. 25	Coniagas	Coniagas Mines, Ltd. ..	A. Hakkala	Machine helper.
11	Aug. 25	do	do do ..	J. McAlpine	Millman ......
12	May 16	Dome Lake	Dome Lake Mining and Milling Co.	H. Filyx	Machine runner
13	Aug. 31	Hollinger	Hollinger Consolidated .	W. Dilinski	do do
14	Oct. 20	do	Gold Mines, Ltd.	F. Papin	Mechanic .....
15	Dec. 11	do	do do	G. Solentre	Trammer .....
16	July 14	Hudson Bay	Hudson Bay Mines, Ltd.	T. Bond	Teamster .....
17	Aug. 22	McIntyre	McIntyre Porcupine Mines, Ltd.	D. Boomer	Machine runner
18	Sept. 29	McKinley-Darragh	McKinley - Darragh-Savage Mines, Ltd.	N. Kirischuk	Trammer .....
19	Oct. 20	Miller Lake	Miller-Lake O'Brien	H. Hutt	Engineer .....
20	Mar. 18	Garson	Mond Nickel Co.	J. Kulyczyaki	Trammer .....
21	Apr. 19	Levack	do do	H. Yates	Hoistman .....
22	Jan. 12	Nipissing	Nipissing Mines, Ltd..	J. David	Machine helper.
		do	do do ..	L. Lauzon	do do
23	Apr. 10	Sylvanite	Sylvanite Gold Mines..	L. Gruby	Machine runner
24	Aug. 18	Teck-Hughes	Teck-Hughes Gold Mines	J. Hemmi	do do
25	Apr. 17	Trethewey	Trethewey Silver Cobalt Mine	A. De Leury	Trammer .....

Table of Fatal Accidents at

No.	Date 1917	Name of Works.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
26	Jan. 23	Blast furnace	Algoma Steel Corp'n....	E. Prevost	Stove tender ..
27	Feb. 20	do do ..	do do	P. St. Jules	Labourer .....
28	July 7	do do ..	do do	R. Elder	Foreman .....
29	Feb. 24	Reverberatory ...	Canadian Copper Co. ..	G. Danis	Coal dryer......
30	Jan. 24	Smelter	Mond Nickel Co.	J. Gardy	Ladle man ....
31	Feb. 21	Smelter yard	do do	A. Beauvois	Labourer .....

Table of Fatal Accidents

32	June 25	Quarry	Bruce Mines, Trap Rock Quarry	J. Deyell	Machine runner
	do	do	do do	Chas. Munroe	Machine helper.
33	June 29	do	Dominion Mines and Quarries	T. Kuryi	Labourer .....
34	Aug. 7	do	do do	C. Bennett	Machine runner

or about the Mines, 1917

Nationality of Deceased.	Age.	Married or single.	Below ground.	Above ground.	Cause of Accident.
English-speaking ...	55	M	......	1	Slide of lumber from loaded car.
Finn	25	S	1	......	Struck by falling timber in raise.
German	39	M	1	......	Caught by fall of rock in stope.
Bulgarian	30	M	1	......	Returned before all sand blasts had exploded.
do	28	M	1	......	Went into hung-up chute to blast.
Austrian	20	S	1	......	Crushed between chute timber and train. Died August 11 from pneumonia.
English-speaking ...	26	M	1	......	Fell down raise while helping to lower truck.
Austrian	33	M	1	......	Walked into blast.
English-speaking ...	32	M	.....	1	Struck by cable of counter-weight.
Finn	30	M	1	......	Fell about 25 feet when lagging broke.
English-speaking ...	36	M	.....	1	Killed while replacing belt.
Austrian	28	M	1	......	Killed by explosion while blasting round.
Russian	24	S	1	......	Struck by rock from blast.
English-speaking ...	39	S	.....	1	Struck by skip on tramway to mill.
Italian	43	S	1	......	Fell down ore pass while dumping car.
English-speaking ...	47	M	.....	1	Kicked by horse while unhitching.
do do ...	35	M	1	......	Struck by block of timber in shaft.
Russian	32	S	1	......	Killed while riding skip.
English-speaking ...	30	M	.....	1	Slipped and fell under locomotive.
Austrian	43	S	.....	1	Thrown over dump while dumping car.
English-speaking ...	32	M	1	......	Fell down shaft.
do do ...	36	M	1	......	Caught by fall of rock while scaling in winze.
do do ...	24	S	1	......	Same accident as above. Died from pneumonia Jan. 19.
Austrian	25	S	1	......	Fell while timbering in shaft.
Finn	36	M	1	......	Struck by rock rolling down pile. Died Sept. 26, 1917.
English-speaking ...	25	S	1	......	Caught by fall of rock in stope.

Metallurgical Works, 1917

Nationality of Deceased.	Age.	Married or Single.	Cause of Accident.
English-speaking ...	24	S	Bolt closing door of stove broke when nut was being tightened.
do do ...	59	M	Run over by railroad car.
do do ...	58	M	Asphyxiated in gas-washing building.
do do ...	28	S	Fell from platform.
Austrian	23	S	Crushed by ladle.
English-speaking ...	19	S	Crushed against platform by passenger coach.

at Quarries, 1917

English-speaking ...	30	M	Powder in shed near men exploded.
do do ...	28	S	Same accident as above.
Austrian	45	M	Wound around drive shaft of conveyor belt.
English-speaking ...	44	M	Fall of rock from face of quarry.

MINES OF ONTARIO

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, E. A. Collins, Cobalt; J. H. Stovel, Sudbury

I.—NORTHWESTERN ONTARIO

Iron Pyrites

Minitaki Lake.—James Whalen, of Port Arthur, did some work on his pyrites deposit, which is situated on the shore of Lake Minitaki, about 12 miles south, by water route, from Graham station, on the Canadian Government railways. The only outcrop on this claim occurs under the water. A shaft was sunk in the foot-wall to a depth of 75 feet, and a cross-cut run to the vein. Work was discontinued in October, 1917.

Northern Pyrites Mine.—Shipments from this property of the Nichols Chemical Company, Limited, at Northpines, during the season of 1917 amounted to 115,000 tons of pyrites. Ore is shipped only during the navigation season, and is sent from Northpines by rail to Fort William, thence by boat to the various manufacturing plants of the General Chemical Company in the United States. Mining operations are continuous throughout the year. In the winter months the excess ore broken in the mine is stock-piled at the rail-shipping point of the Canadian Government lines.

The production of 1917 was principally obtained from the third level east stopes. Development drifts were run both east and west on the fourth level. The shaft was sunk to a depth of 550 feet, on a 55° incline, and a station cut on the fifth level. It is planned to make such changes in the present equipment as will enable a large tonnage to be shipped in 1918.

G. B. Holderer was superintendent during the shipping season, and was succeeded in November by J. A. Battle, Jr. From 200 to 250 men were employed.

Mokomon.—The Nichols Chemical Company, Limited, concluded their diamond-drilling on the pyrites prospect at Mokomon, in Conmee township, during November, 1917. It is expected that the company will acquire this property. Dr. Warren S. Smith was in charge of the exploration work.

Copper

Port Arthur Copper Company.—This company did a small amount of development work on their property, which is situated south of the main line of the Canadian Northern railway, about four miles west of Mine Centre.

In October, 1917, a 100-h.p. boiler, a 500-cu. ft. air compressor and a 10 by 12-inch steam hoist were being installed. The shaft, a two-compartment one inclined at 80°, had been sunk to a depth of 55 feet. It was planned to sink farther and do considerable drifting as soon as the headframe and hoist were ready.

The company has a capitalization of $2,500,000. The officers of the company are: Fred M. Connell, of Toronto, president; J. F. Hewitson, of Port Arthur, vice-president; J. A. M. Alley, 904 Bank of Hamilton Building, Toronto, secretary-treasurer.

W. H. Connell was manager, employing about 15 men.

Tip Top Mine.—S. W. Ray, of Port Arthur, re-opened the Tip Top mine in 1917, shipping to the Trail smelter in British Columbia. The mine is located about 6½ miles south of the main line of the Canadian Northern railway from a point two miles west of Kashaboiwe station.

A narrow-gauge track was laid from the mine to the railway and the ore cars are hauled over this by a dinkey locomotive. The mine had previously been opened to a depth of 200 feet and drifts run every 50 feet of depth. Only the first and second levels (50 and 100-foot depths) had been de-watered up to October, 1917, the ore produced having come from above these levels. At that time the mine was shipping about 45 tons daily.

S. W. Ray, of Porth Arthur, is owner and operator, Mr. Flatt being in charge at the mine: 40 men were employed.

Gold

St. Anthony Mine.—The Thunder Mining Company continued development work on the St. Anthony mine until September, 1917, when the property was closed down for the winter months. Development work done by this company consisted of 1,500 feet of drifting, 100 feet of raising, and 150 feet of sinking. The mill was run for a short time for sampling purposes.

The Kerr Lake Mining Company, which operates the well-known silver mine of this name at Cobalt, holds approximately two-ninths' interest in the new company.

H. H. Lavery was superintendent, employing 60 men.

Rognon.—The Rognon Gold Mines, Limited, commenced operations in June, 1917, on the Rognon claim, which is situated on Contact bay, Wabigoon lake, about eight miles south of Dryden. A small boiler, compressor and hoist were installed, and 70 feet of sinking, 60 feet of drifting and 50 feet of raising done. A single Nissen stamp, with amalgamating plates, was installed and used for testing purposes.

The company is capitalized at $2,500,000. J. M. Beckley, Rochester, N.Y., is president; S. J. Madden, Toronto, vice-president and manager; and J. R. L. Starr, Toronto, secretary. S. J. Madden was in charge and employed about 10 men.

Tash Orn.—The description of this property, contained in the Bureau's Twenty-sixth Report, represented the work done up to June, 1917. The mine was closed shortly afterwards and has not been re-opened.

II.—SUDBURY, NORTH SHORE AND MICHIPICOTEN

Iron Ore

Helen Mine.—Operations at this mine, owned by the Algoma Steel Corporation, consisted in drawing off the caved hematite ore. At the end of 1917 only a portion of the seventh level and a small area on the eighth level remained to be drawn off, so that it seems probable that the Helen hematite ore body will be finished early in 1918. All ore hoisted was shipped to the Magpie mine, where it is roasted to eliminate the high sulphur content. During 1917, 2,825 tons of pyrites were mined and 99,238 tons of hematite.

In October, 1917, preparations were being made to drive a development tunnel underneath the large siderite deposit at this mine, which was diamond-drilled in 1916 and 1917. This deposit adjoins and also underlies the original hematite ore body. The entrance to the tunnel will be on the north side of the hill or deposit which is farthest from the present mine buildings. This tunnel will tap the ore body about 300 feet below the top of the hill, and a large tonnage will be available above it. It is planned to mine the portion of the ore body above the tunnel by open-pit method. Electric haulage to the roasting plant, which will be erected not far from the tunnel entrance, will be used.

G. R. McLaren, Helen Mine, Ont., is superintendent. About 100 men were employed.

Magpie.—The Magpie mine of the Algoma Steel Corporation produced 184,592 tons of roasted ore during 1917, and shipped 197,561 tons. Scarcity of labour prevented the mine from being operated to full capacity. The ore produced came from the second and third level stopes. Considerable development was done on the fourth level during the year. In the summer this mine, as well as the Helen mine of the same company, was put on an eight-hour working basis for underground work.

A. Hasselbring, general superintendent of mines for the company, is in charge at the Magpie mine. From 200 to 230 men were employed.

Dreany Bros.—Dreany Bros., of Toronto, did some surface stripping and trenching on a banded magnetite iron deposit near the Algoma Central railway, four miles north of Goudreau. Further testing was to be done by diamond-drilling. C. D. Daimpre was in charge.

Rand Pyrite Mine.—Early in 1917 the Rand Consolidated Mines, Limited, commenced opening up a pyrite deposit near Goudreau station, on the Algoma Central railway. Considerable surface work was done during the year and a trial shipment of two cars made. A 250-h.p. boiler had been installed, and a crusher and compressor were being put in.

The company is incorporated with a capitalization of $5,000,000, but permanent officers have not been elected. Allan W. Jackson, of Goudreau, was manager; about 25 men were employed.

Grace Gold Mine.—The Grace mine, a former gold producer, situated not far from Wawa station, on the Michipicoten branch of the Algoma Central railway, was pumped out during the latter part of 1917. The work was done for a Pittsburg (Pa.) syndicate, Robt. Patterson being in charge. No mining was done.

Nickel and Copper

The Canadian Copper Company

The Canadian Copper Company operated during 1917 the following mines: Creighton, Crean Hill and Dill quartz quarry.

The officials of the company are: President, A. D. Miles; general superintendent, J. L. Agnew; superintendent of mines, J. C. Nicholls; smelter superintendent, W. Kent; chief engineer, E. H. Jones; safety engineer, E. T. Corkill.

Copper Cliff Smelter.—The smelting capacity was enlarged by the addition of another furnace, No. 8. This furnace is the same size as No. 7, 25 ft. 6 in. by 50 in. The smelting capacity was further increased by the lowering and enlarging

One of the sorting floors, Creighton mine rock house.

of all the settlers. By this change the slag from the converters can be poured directly into the settlers instead of being sent to the furnaces. A sixth converter was added.

Creighton Mine.—During 1917 the Creighton mine shipped 1,003,816 tons of ore. Work was carried on in all levels from the second to the fourteenth, the main production coming from the tenth and twelfth levels. Most of the breaking was done in the twelfth level stopes. The fourteenth level was opened up by cross-cuts, and other development and stoping begun. The work above the tenth level was scattered over miscellaneous areas. During the first part of the year No. 3 shaft was completed and put into commission.

Crean Hill Mine.—The output for 1917 was obtained principally from the fifth and second levels, and amounted to 133,907 tons.

C. Collins is superintendent, employing from 250 to 300 men.

British America Nickel Corporation

The British America Nickel Corporation continued the development of the Murray mine, and began building operations on the smelter site during 1917.

The authorized capital stock of the corporation is $20,000,000, divided into 200,000 shares of common stock of a par value of $100.

View showing arrangement of lockers in change house, Creighton mine.

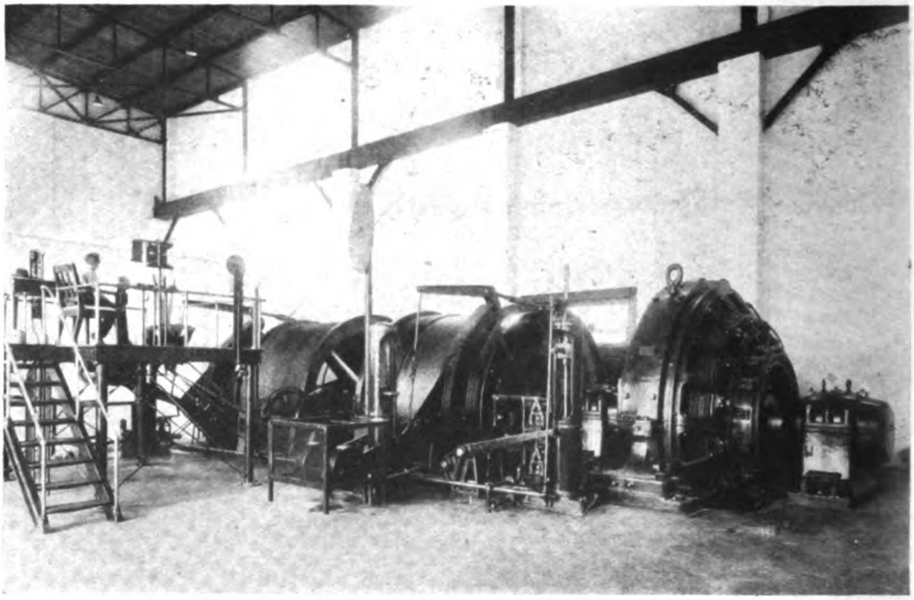
The officers of the company are: President, J. H. Dunn; vice-president, W. A Carlyle; secretary and treasurer, W. H. Coade; general manager, E. P. Mathewson. The head office is at the Royal Bank Building, Toronto.

In the spring of 1918, E. P. Mathewson severed his connection with the company, and W. A. Carlyle assumed the duties of manager. The head office was moved from Toronto to Ottawa, and the construction of a refinery was commenced near Hull on the Quebec side of the Ottawa river.

Murray Mine.—At the Murray mine the 3-compartment incline shaft was continued to the 900-foot level, with levels at 150, 300, 400, 500, 600, 700, and 800 feet, and ore pockets at the 300, 500, and 700-foot levels.

A shaft house is under construction. This building is of steel and reinforced concrete 60 feet by 64 feet, and is 102 feet high. The crusher is 36 inches by 48 inches. The waste bin is 400-ton and the ore bin 500-ton capacity.

From the shaft house the ore is conveyed by a 30-inch travelling belt to the rock house, a distance of 279 feet. The rock house is 88 ft. by 126 ft. of steel and gunnite construction on a concrete foundation. The bins are of reinforced concrete.



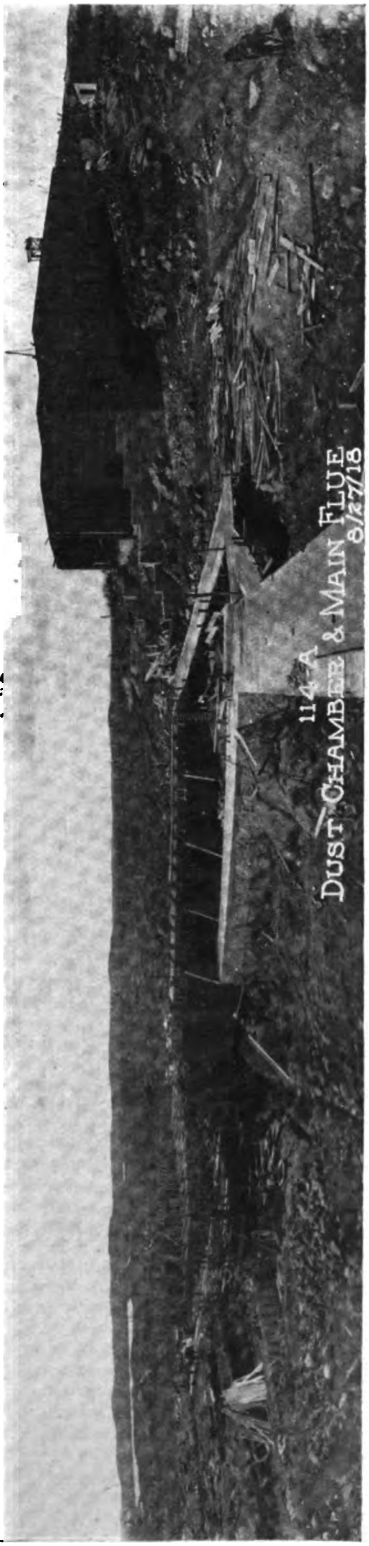
Ore hoist at Creighton mine.

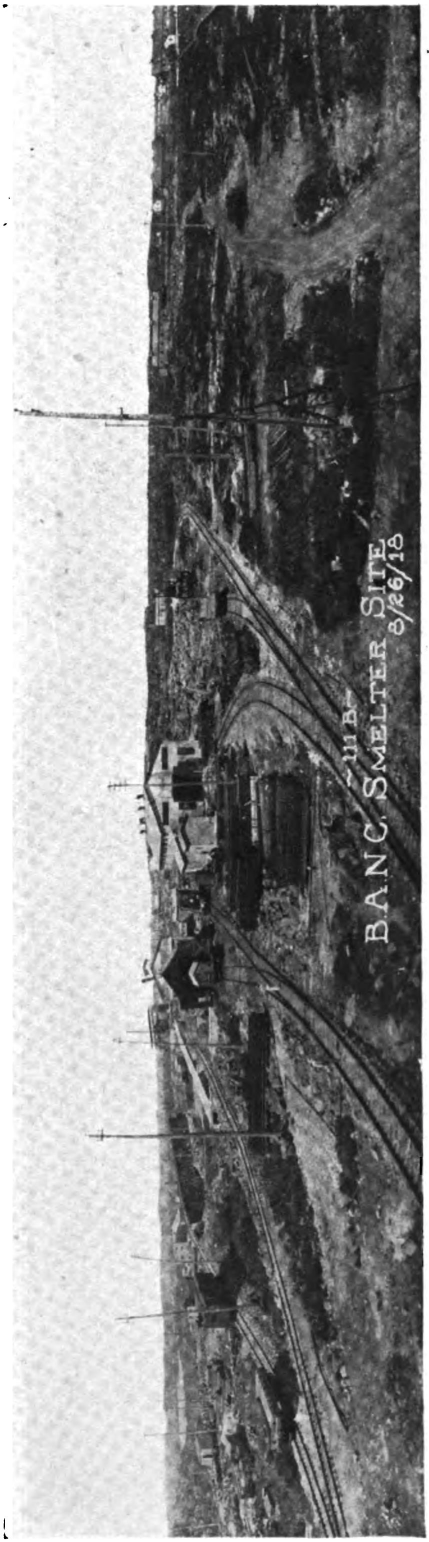
The equipment comprises a 36-in. by 18-in. jaw crusher, a No. 5 gyrating crusher, picking belts, screens, etc. A one-storey brick change house, 97 ft. by 57 ft., is nearly completed. The power house at the mine is 107 ft. by 134 ft. The installation will include three 500-h.p. Babcock and Wilcox boilers.

Smelter.—The smelter site is 1¼ miles from the mine. Eight miles of standard-gauge railroad have been built, connecting the mine with smelter yards. These tracks are connected with both the Algoma Eastern and Canadian Pacific railways.

The smelter buildings completed and those under construction include a warehouse 41 ft. by 144 ft. of steel and gunnite; machine shop, including boiler shop 50 ft. by 160 ft. of steel and gunnite: change house, 57 ft. by 113 ft., of reinforced concrete and brick; power house, 198 ft. by 83 ft., of steel and brick; smelter building, 378 ft. by 67 ft.; dust chambers, 77 ft. by 120 ft., of brick and steel.

The equipment in the power house will include six Babcock and Wilcox boilers and two 2,500-cu. ft. Bellis and Morcum air compressors.

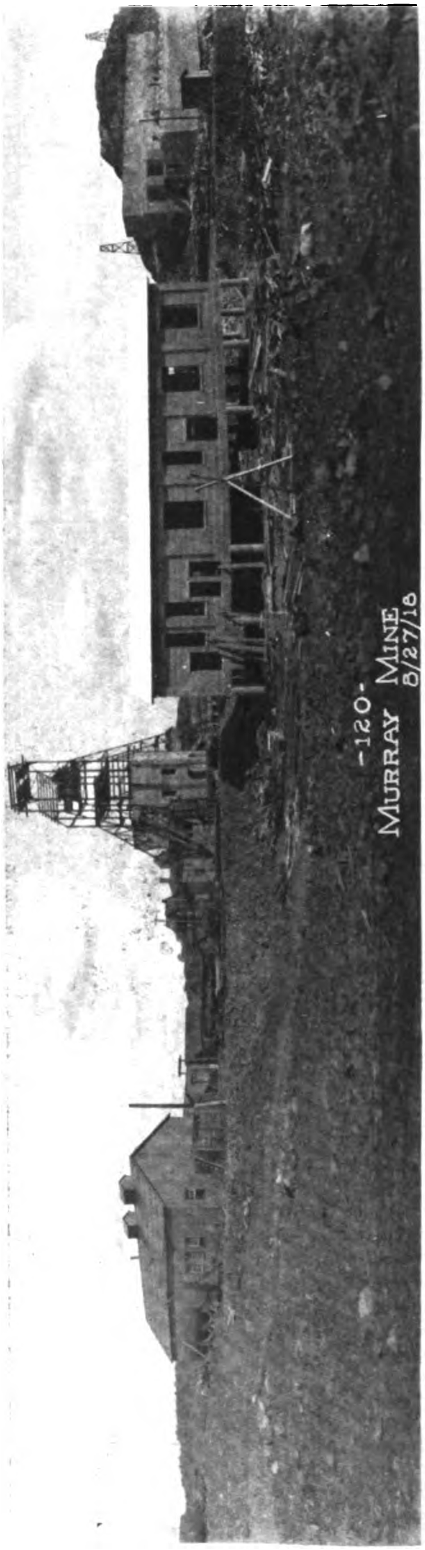




Views of smelter at Murray mine under construction by the British America Nickel Corporation.

Rock house, Murray mine.

Shaft house, Murray mine.



General view of Murray mine, showing shaft house in centre and rock house on right. British America Nickel Corporation.

Mond Nickel Company, Limited

The Mond Nickel Company, Limited, operated in 1917 the Victoria, Garson, Worthington and Levack mines, in the Sudbury field, and Bruce Mines, situated in the village of that name.

The head offices of the company in Canada are at Coniston. The officials are: C. V. Corless, manager and also a director of the company; J. F. Robertson, superintendent of reduction works; O. Hall, mines superintendent; W. L. Dethloff, chief engineer; W. H. Soule, electrical superintendent.

Bruce.—No. 1 mine shipped 32,500 tons to the smelter in 1917. The shaft was continued to the fifth level, a depth of 427 feet. A drift is being run from this point to connect with the workings at the bottom of the old No. 2 shaft, and it is planned to prospect this area more thoroughly.

At the No. 2 mine, formerly the Taylor shaft, development was continued on the 150-foot level during the year. About 1,000 feet of drift was driven. No stoping was done.

A. D. Carmichael, Bruce Mines, is superintendent. From 75 to 85 men were employed.

Garson.—The output from this mine in 1917 was 117,000 tons, this ore being obtained principally from the sixth level stopes. Development on the eighth level was continued and several stopes were prepared for mining by section-cutting on the sub-level. Development on the tenth level was confined to drifting and cross-cutting. The drifting, cross-cutting and raising done in the mine during the year was 4,000 feet. J. R. Thoenen is superintendent. About 300 men were employed.

Levack.—The Levack mine shipped 88,500 tons of ore to the smelter in 1917. This ore was mainly obtained from the second and third level stopes. During the year development was continued on the fifth level. The shaft, which is inclined at 65 degrees from the horizontal, was sunk to the seventh level, a vertical depth of 590 feet, and a station was cut at the seventh level. A club house and 13 more cottages were erected in the company village.

F. J. Eager is superintendent. About 300 men were employed.

Victoria No. 1.—This is still the deepest mine in Ontario. The shaft was 2,750 feet in depth at the end of the year 1917, and was to be continued to the 3,000-foot level before another station was cut. The mine produced in 1917 46,000 tons of ore. Stoping was carried on in nearly every level.

W. J. Mumford is superintendent; 145 men were employed.

Worthington.—This mine shipped 75,000 tons of ore to the smelter in 1917. Stoping was carried on above the second and third levels. The fourth level was developed by drifts and cross-cuts and the stopes opened up by section-cutting on the sub-level. The shaft was continued to a vertical depth of 750 feet, and a fifth level station was cut at that depth.

R. H. Palmer is superintendent; about 275 men were employed.

Reduction Works.—The production of the Coniston smelter during 1917 was about the same as in 1916. Two furnaces and two converters were operated con-

tinuously; the sintering plant and the concentrating test plant ran steadily. The roasting of ore in the roast yards was again confined to the late autumn and winter months.

An additional furnace and converter, with the necessary auxiliary equipment, were under construction and should be ready for operation early in 1918. The smelter will then have four furnaces and converters, so that the production of matte can be largely increased, when desired.

J. F. Robertson is superintendent of all reduction works; E. T. Austin, superintendent of the smelter; K. S. Clarke, superintendent of the sintering and concentrating plants.

Safety Organization.—At the Coniston reduction works safety matters are in the hands of two committees: Supervising, and Auxiliary. The former committee decides what changes are to be made. The chairman is the manager of the company, and the secretary is the head of the office staff. The six other members are the heads of departments together with the men next under them in direct charge of the work, viz.: the superintendents of reduction works, smelter, sintering and test plants, representing operations, and the chief engineer and mechanical and electrical superintendents, representing construction, maintenance and repair. These six men act in rotation as chairman of the auxiliary committee, the other members of which are foremen, sub-foremen or workmen, one from each of the following: Smelter, sintering and test plants, mechanical and electrical departments, and yard, each being selected by his own superintendent. Three of the members of the auxiliary committee are changed every fortnight, *i.e.,* each is a member for four weeks; thus in a short time a very considerable number of the men in the plant have been members of this committee. The inspection is in the hands of this committee, every second Monday afternoon being devoted to the work. Each unsafe practice, or unsafe piece of equipment detected, is made the subject of a brief report on a printed form, this report containing a recommendation as to the manner of removing the danger.

The supervising committee meets next day, and the reports of the auxiliary committee are presented by the member of the supervising committee who has acted as chairman of the auxiliary committee. After the reports are discussed a decision is made as to what action shall be taken. Practically all recommendations of the auxiliary committee have been passed as received, three or four only having been set aside as unnecessary, and a few amended as to the methods of eliminating the danger; no recommendation has been overruled on account of cost. The supervising committee also discusses recommendations from any of its own members and from a suggestion box hung near the time-check wicket. Once a month the accidents which have occurred during the preceding months are discussed, and the records compared with those of former periods. Should a serious accident occur, the auxiliary committee meets as soon as practicable and investigates, reporting to the supervising committee.

The above organization for safety has worked very effectively and smoothly. It has now been in operation for eighteen months, and the decrease in the number of accidents has been very marked.

The only change in procedure has been the reduction of the number of inspections and meetings from weekly to fortnightly after most of the points needing attention had been remedied.

The committee realizes the responsibility of its work. An important part of the scheme is the rotation of the foremen, sub-foremen and workmen through the auxiliary (*i.e.*, inspecting) committee. Each man goes through his own and other parts of the plant devoting all his attention to safety considerations, in most cases carrying back to his work a great deal of the safety point of view. The more important men are put on the auxiliary committee again after a considerable interval.

Another point in the same connection is the absence of any division of authority. The foreman, or sub-foreman, the man who must get the work done quickly and cheaply, is also, or has been, a member of the safety committee to make that work safe, and he knows that his superintendent is a member of the safety organization all the time and is depending on him, the foreman, to help keep the number of accidents at a minimum.

Miscellaneous Mines

Goudreau Pyrite.—The Nichols Chemical Company shipped from their mine at Goudreau, during the season of 1917, 110,000 tons of pyrites. Ore is shipped only during the navigation season, by rail from Goudreau to Michipicoten Harbor, and thence by boat to the various plants of the General Chemical Company in the United States. The ore shipped in 1917 was obtained from "C" deposit, which was the first opened and is about 1,000 feet from the mill. In the autumn of 1917 a second deposit, known as the "Bear," was being prepared for production in 1918. This deposit is over a mile from the crushing plant, and the ore from it will be handled to the mill over a narrow-gauge track. The crushing plant is being almost entirely changed, and the new installation includes a No. 12-K Gates gyratory crusher, which will greatly increase future production.

J. A. Battle, Jr., was superintendent until October, 1917, when he was transferred to the Northern Pyrites mine, which is also one of the properties of the Nichols Chemical Company, Limited. He was succeeded by Gerald G. Dobbs. About 200 men were employed throughout the season.

McDonald Copper.—The Cheney Copper Mines, Limited, did a small amount of work on the McDonald and Jackson claims, situated on lots 6, 7, 8, 9 and 10, in the fifth concession of Gould township, north of Thessalon. No ore was shipped.

Hudson Copper.—The Hudson Copper Company did some development work on a copper-quartz claim situated about two miles north of Havilah. A shaft 60 feet deep was sunk and considerable surface trenching done in the vein. One car of ore was shipped.

John Black was in charge, five men being employed.

Rutherglen.—The Mattawan River Mining and Milling Company, Limited, sank a 50-foot shaft and did about 50 feet of drifting on a claim which adjoins the main line of the Canadian Pacific railway, about two miles east of Rutherglen. A small boiler, compressor and hoist were installed. The mine was closed down in the autumn of 1917.

Sudbury Copper.—The Sudbury Copper Company, Limited, continued development of their property near Iron Bridge. The shaft was sunk to a depth of 250 feet and a small amount of drifting done on the 150-foot and 250-foot levels. A powder house, change house, and several cottages were built.

George E. Bent, Iron Bridge, was manager; from 15 to 20 men were employed.

Moose Mountain Iron Mine

Moose Mountain, Limited, has an authorized capitalization of $4,000,000 divided into 400,000 shares of a par value of $10.

The officers of the company are: President, Chas. E. Herrmann: secretary-treasurer, Gillison C. Lott; directors, L. B. Miller, Cleveland; John T. Mitchell, Chicago; Donald D. Mann, Toronto; James C. Hutchins, Chicago; Chas. H. Smith, New York; John B. Dennis, New York; William Mackenzie, Toronto; Chas. E. Herrmann, New York; Augustine L. Humes, New York; David Dows, New York: John F. Harris, New York. The head office is at 17 Battery Place, New York.

The mine officials are: A. J. Anderson, general manager; H. H. Hodgkinson, mine superintendent, Sellwood, Ont.

During the year the main tunnel and "B" drift (10 ft. by 11 ft.) was driven 451 feet, and "A" drift (5 ft. by 7 ft.) was driven 339 feet; "A" drift for a distance of 711 feet was enlarged from 5 ft. by 7 ft. to 10 ft. by 11 ft. The other underground work consisted of: winzes, 93 ft.; raises, 9 ft.; raises for chutes, 182 ft.; and level drifts (5 ft. by 7 ft.), 509 ft.; diamond-drilling amounted to 5,170 ft.

Ore sent to the mill amounted to 12,947 tons, of which 4,773 tons came from No. 1 dust pile; 5,500 tons from development work; 2,038 tons from the stopes, No. 2 tunnel; and 636 tons from No. 2 pit.

The results now being obtained in the mill are considered satisfactory by the company. The concentrates are pressed into bricks 8 in. by 4 in. by 2¼ in., weighing 7½ lbs. when burned. In the kilns the bricks are subjected to a maximum temperature of 2,200 F., and are of a sufficient hardness to stand transportation and smelting.

The machinery installed included a No. 86 Marcy mill, an 8 ft. by 36 in. Hardinge mill, a 4-mould No. 701 American clay machinery briquette press, and a 6 ft. by 6 ft. Oliver filter. Additional filters and moulds are being installed.

Quarries

Killarney.—Willmott and Company, of Toronto, sold their quartz quarry, located on Georgian bay, not far from Killarney, to Electro-Metals, Limited, of Welland. It was operated during the season of navigation by Willmott and Company, who had a contract for getting out the quartz. The shipments went to the ferro-silicon plant of Electro-Metals, Limited. Some changes and additions were made to the crushing and conveying machinery.

Dan Chisholm, of Killarney, was in charge, and employed 45 men.

Bruce Mines Trap Rock.—This quarry was operated until midsummer in 1917 by W. S. Edwards, trustee, of Sault Ste. Marie, Mich. The quarry was then shut down because boats to ship the product could not be procured.

E. Mitchell, Bruce Mines, was in charge; about 60 men were employed.

East Neebish Island.—This quarry, owned and operated by the Dominion Mines and Quarries, Limited, shipped 57,000 tons of quartz to Buffalo, N.Y., during the season of navigation. Additional equipment is to be added to enable the company to increase their shipments in 1918.

I. Appleton, of McLennan, was in charge; about 60 men were employed.

III.—DISTRICT OF TIMISKAMING

Gold

Boston Creek and Munro Township

Baldwin.—The Baldwin Gold Mining Company, Limited, owns the north half of lot 2 in the sixth concession of the township of Eby. The shaft and camps are located near the right-of-way at mileage 167½, T & N. O. railway. Work was carried out at intervals during the year and a vertical shaft sunk to a depth of 100 feet.

The plant included one 65-h.p. portable boiler; one 6 by 8 Jenckes hoist; and a small compressor, 300 cubic feet capacity.

Hugh Baldwin was manager of the mine, employing ten men.

Bourkes Mines.—Bourkes Mines, Limited, did considerable surface prospecting and trenching on their promising discovery near Bourkes station, in the first concession of Benoit township.

The vein strikes north about 20 degrees west, and when inspected on November 15th, 1917, had been open-cut for a distance of 100 feet, and in the vicinity of the original discovery showed considerable free gold.

It was the intention of the company to erect camps and diamond-drill during the winter.

The directors are: Charles Millar, Charles Gentles, and Archie Burton, all of Toronto; Alex. Gillies and John J. Byrne, Bourkes.

Burton-Munro.—Burton-Munro Mines, Limited, worked continuously during the year on their claims situated on the north half of lot 11, in the first concession of Munro township. The incline shaft was sunk to a depth of 318 feet, with stations at the 148 and 300-foot levels. On the first level 96 feet of cross-cutting and drifting was done, and on the bottom level 735 feet. Operations were suspended in February, 1918.

The head office address is 55 Yonge Street, Toronto. The officers and directors are: Charles Millar, president; Charles Gentles, Archie Burton. David Sloan was manager.

Croesus.—With the exception of a temporary shut-down in July, 1917, while the pumping capacity was being increased, the Croesus Gold Mines, Limited, worked continuously throughout the year. Underground development was practically confined to the 300-ft. level, where 700 ft. of cross-cutting and drifting was done. Ore stoped was produced on the two upper levels. The mine was closed down on February 15th, 1918. Julius Cohen, manager, resigned in September, 1917, to join the American overseas forces, and was succeeded by Charles Lobner, who had charge of operations until the mine closed in February.

The officers are: President, D. M. Steindler, New York; vice-president, Mortimer Davis, Montreal; secretary-treasurer, E. L. Steindler, Cobalt. The head office of the company is 42 Broadway, New York.

Hill.—The Hill Gold Mining Company own 160 acres in the township of Beatty, near Painkiller lake, and about seven miles from Matheson. Development began in the autumn of 1917 and a shaft was sunk to a depth of 125 feet. The plant includes two 60-h.p. boilers, one 25-h.p. boiler, and one Rand compressor, capacity 1,200 cubic feet.

A 70-ton mill is in course of erection, and will be ready for operation in the summer of 1918.

The officers are: President, W. H. Hill, Boston; directors, G. Smith, Boston; Senator Bowen, Providence, R.I.; and A. M. McEvoy. J. Hill is mine manager.

Murray-Mogridge.—The Murray-Mogridge Mining Company, Limited, own ten claims on lots four and five in the fifth and sixth concessions in the township of Maisonville. The mine is reached by wagon road from Bourkes station, T. & N.O. railway, a distance of four miles. The oamp buildings are erected on the east shore of Wolf Lake.

The officers are: President, C. E. Jury, Toronto; vice-president, W. W. Sloan, Toronto; secretary-treasurer, C. J. Bielby, Toronto; head office, Union Bank Building, Toronto; directors in addition to above officers: F. C. Annesley, D. I. Grant, N. Schaeffer, all of Toronto; and J. J. B. Cooper, New York. Manager, G. G. Thomas, and mine captain, John McCallum.

Active development began on June 15th, 1917, and was continued to the end of the year. When visited in November the shaft had been sunk to a depth of 226 feet with working levels at 50, 100, and 200 feet.

A total of 250 feet of cross-cutting and drifting had been done on the three levels. Twenty-five men were employed.

Miller Independence.—Miller Independence Mines, Limited, carried on active development work throughout the year on their property, south half of lot 1, Concession VI., township of Pacaud. This was a veteran claim, originally owned by English interests, and purchased by F. M. Connell, of Toronto, when gold was discovered in 1915. The claim was then purchased by George J. Miller, of Ohio, who formed the above company. Several shafts have been sunk to varying depths, and the veins carried considerable values in free gold in many places. In the summer of 1918, a discovery was made near the north boundary which carries very

high values in tellurides and free gold, and a shaft designated as "D" shaft had been sunk to a depth of 100 feet in July, 1918. The vein at this point appears to have a definite east and west strike and dips to the south at about 40° from the horizon.

During the year "C" shaft was sunk to a depth of 110 feet, with levels at 44 feet and 100 feet. On the first level 200 feet of drifting was done, and on the 100-foot level cross-cuts were driven 112 feet to the south and 80 feet to the north.

A test mill run of 250 tons was made during the year.

The officers are: President, Geo. J. Miller; vice-president, N. W. Kirkpatrick, Dayton, Ohio; secretary, John C. Schaeffer, Germantown, Ohio; treasurer, Ed. Rettich, Germantown, Ohio; directors, O. B. Brown, Wm. Stroup, Geo. W. Ozias, J. A. Read, and J. A. Beagard, all of Dayton, Ohio.

Patricia Syndicate.—The property of the Patricia Syndicate, formerly known as the Boston-Hollinger, consists of two 40-acre claims in the north half of lot 3, in the sixth concession of the township of Pacaud, one mile south-east of Boston Creek station, on the Timiskaming and Northern Ontario railway.

The property was taken over under option by the Patricia Syndicate on August 15th, 1917.

The mine plant consists of two 50-h.p. locomotive boilers, one Canadian Ingersoll-Rand two-stage air compressor of a capacity of 500-cu. ft. of air per minute, and a Jenckes 6 by 8 hoist.

The work done to date has been confined to two of the 12 known veins; most of this work has been concentrated on the No. 7 vein, which is in the north central part of the west claim. This vein is in the Keewatin series, and strikes east with a dip of 74° south. It has been opened by trenching for a length of 700 feet and a two-compartment shaft has been sunk on it to 215 feet, with stations and pockets at the 100 and 200-ft. levels. On the first level 305 feet of drifting had been done to May 20th, 1918, and three stopes opened out above the level. The 200-foot level is now being opened up in the same manner. The vein consists of two and sometimes three sections of quartz with some calcite lenses on the foot and hanging-wall sides. The ore contains one or two per cent. sulphides, consisting mainly of chalcopyrite and chalcocite with patches of hornblende. The gold is for the most part free and is visible in much of the high-grade ore. The width of vein varies from 8 to 40 inches, with an average width of 26 inches of primary quartz.

The mill has been erected 225 feet north of the "A" shaft, and is now ready for operation. The ore is trammed from the shaft bin in one-ton cars, and as it enters the mill building is weighed on a Fairbanks scale. The ore is crushed in a 9 in. by 15 in. Blake-type crusher fitted with manganese jaw plates, and from there is elevated to the top of the 100-ton ore-storage bin. It passes through a trommel, which is fitted with a punched screen having one-inch openings, and the oversize returns to the crusher bin. From the storage bin it is fed by a belt-driven Challenge feeder to the feed box of the ball-tube mill. This mill is a 5 ft. by 6 ft. Allis-Chalmers type, fitted with cast-iron step-lifter liners. The ball charge is made up of 1, 1½, 2, and 3-inch balls, the total load being 7 tons. From the ball mill the pulp passes over a set of primary amalgamation plates to a Dorr

classifier, where the oversize is elevated to the feed box of the ball mill for further reduction. The undersize (minus 40-mesh) is sent over a set of secondary amalgamation plates and thence to three No. 6 Wilfley tables, where the sulphides are removed. The tailings are impounded for possible treatment at a future time. The concentrates are dried in a steam-drying pan and sacked for shipment to the smelter.

The mill has a capacity of 50 tons daily. Water is obtained from a small lake north of the mill.

Chas. A. O'Connell is manager, employing 50 men.

Kirkland Lake

Active development was carried on in the Kirkland Lake camp in 1917. Operations at the producing mines and development at the prospects received a decided impetus by the delivery of electric power early in the spring. Mill construction at the Kirkland Lake Gold Mines, Limited, operated by the Beaver Consolidated Mines, Limited, of Cobalt, was stopped after the foundations were in place in December, 1917, but it is stated that this mill will be completed during 1918. The Lake Shore company erected a 75-ton mill and made the first run on March 8, 1918.

Burnside.—Early in 1918, the Aladdin Cobalt Mining Company, Limited, acquired an interest in the Burnside Gold Mines, Limited, and began active development of the property adjoining the Tough-Oakes.

No. 2 shaft, 90 feet deep, was pumped out and re-timbered, and No. 3 shaft was down to a depth of 85 feet when visited in April, 1918.

Two upright boilers were installed for hoisting purposes, and air was supplied by the plant of Sylvanite Gold Mines, Limited. Charles Richardson, of the Aladdin Company, is manager.

Canadian Kirkland.—The Canadian Kirkland Gold Mines, Limited, own four claims in the township of Teck, known locally as the Killoran claims. Prospecting was started in January, 1917, under the direction of Robert R. Tough, and carried on throughout the year. Work consisted of trenching, sinking of test pits on several veins, and the erection of boarding camps. Rocks of the Cobalt series are found in this district, with the porphyry intrusives typical of the formation farther east.

When visited in March, 1918, surface prospecting was still being carried on, with the expectation of installing a mining plant in the summer of 1918.

The officers are: President, A. A. Amos, Cobalt; vice-president, George Tough, Haileybury; secretary-treasurer, G. T. Ware, Haileybury. The board of directors includes the above officers; W. E. Smith, Toronto, and B. G. Killoran, Haileybury.

Elliott-Kirkland.—Work was continued throughout the year on the two claims L1616 and L1617 in the township of Teck, owned by the Elliott Kirkland Gold Mines, Limited. On March 23rd, 1918, the shaft was 433 feet deep, with levels at 120, 220, 320, and 420 feet. The following work was done during the year:—

First level, cross-cutting 184 feet.
Second level, cross-cutting 60 feet.

Third level, cross-cutting 71 feet, drifting 158 feet.

Fourth level, cross-cutting to south 70 feet, drifting east 27 feet, drifting west 92 feet.

About 75 feet from the cross-cut in the west drift, fourth level, a well-defined vein carrying gold values was encountered in March, 1918. Considerable importance was attached to this discovery, as it extended the mineralized area for a considerable distance to the west.

The officers are: President, S. Harry Worth, Philadelphia; vice-president and managing director, R. H. Lyman, Cobalt; secretary, W. A. Gordon, Haileybury. The board of directors includes the above officers; John Wood, 801 Bank of Hamilton Building, Toronto, and E. W. Kearney, Haileybury. Thirty-five men were employed.

Fisher.—The Fisher Gold Mining and Milling Company, Limited (head office, Royal Bank Building, Toronto) did considerable surface trenching and development on their claims in Teck township. In November, 1917, camps were built and preparations were in progress for active development, shaft-sinking, and plant installation. Nothing further was done during the year.

The officers are: President, L. G. Glass, Montreal; secretary-treasurer, John A. Sullivan; manager, S. C. McLaughlin.

Kirkland Lake.—Before closing down, on December 31st, 1917, the Kirkland Lake Gold Mining Company, Limited, completed the main shaft to the 700-foot level, and performed a large amount of development work on the four lower levels. No. 2 shaft, which is more centrally located for mining purposes, was sunk to a depth of 150 feet. The foundations for a 100-ton mill were erected, three electrically operated Aldrich pumps installed, and everything left in readiness for development on a much larger scale when financial arrangements were completed.

Operations were in charge of Frank L. Culver and W. J. Moffatt, of the Beaver Consolidated Mines, Limited; Jay Elliott is resident superintendent, employing 60 men.

The Beaver Consolidated Mines, Limited, owns 1,743,050 shares of this company's stock. Approximately 8,000 tons of ore have been mined from development and are now on the surface ready for milling.

Kirkland Porphyry.—The Kirkland Porphyry Gold Mines, Limited, continued development of their property lying between the Teck-Hughes and Kirkland Lake mines. The shaft was sunk to a depth of 280 feet, and a small amount of cross-cutting and drifting done at the 150-foot and 280-foot levels. The vein was encountered at both levels, and values were sufficiently high to ensure further development. Twenty-five men were employed under the management of H. Cecil.

Lake Shore.—Active development was carried on throughout the year by the Lake Shore Mines, Limited. The main shaft was sunk to the 400-foot level, both No. 1 and No. 2 veins having been explored on this level.

Development work for the year ending November 30th, 1917, may be summed up as follows:—

Drifting and cross-cutting	200-foot level	2,000 feet.
" "	100 " "	200 "
" "	300 " "	250 "
" "	400 " "	180 "
Sinking shafts and sumps		150 "
Raising		85 "
	Total	2,865 feet.

Construction work on the new mill started September 1st, 1917, and the first run was made on March 8th, 1918. The ball and tube mill grinding plant has a capacity of 65 tons per day, and the cyanide end of the mill is equipped to treat 100 to 125 tons per day. The grinding capacity may be increased as desired without interference with the operations of the mill.

The officers are: President and managing director, Harry Oakes; vice-president, Arthur G. Slaght; treasurer, Dr. Conrad E. Wettlaufer; secretary, Kirkland Securities Corporation, Limited.

John W. Morrison was manager during the year. The mill was designed and built under the direction of D. J. Coffey, who succeeded Mr. Morrison as manager in April, 1918.

Minaker.—The Minaker Gold Mines, Limited, did a small amount of development on their group of claims lying south of the Lake Shore mine. No. 1 shaft was sunk to a depth of 45 feet, and No. 2 shaft to a depth of 25 feet.

Considerable surface trenching was performed. Work was in charge of T. J. Flynn, employing 5 men.

Sylvanite.—The Sylvanite Gold Mines, Limited, own the following claims in the township of Teck, adjoining the Tough-Oakes on the west: Nos. L 2100, 2101, 2256 and 2257.

A plant was installed in 1916 and mining operations resumed in April, 1917. Operations were suspended on the first of June, 1917, and since that date no work has been done. The plant consists of a 440-cu. ft. Ingersoll-Rand compressor, one 6 by 8 Jenckes hoist, one 75-h.p. motor and one 60-h.p. boiler.

A shaft was sunk to a depth of 120 feet, and 169 feet of cross-cutting and drifting done on the 100-foot level.

The officers of the company are: President, Harry Oakes; vice-president, Ralph Robbins, Timmins; secretary-treasurer, M. Green, 85 Bay Street, Toronto.

Work was in charge of J. W. Morrison, manager of the Lake Shore mine.

Teck-Hughes.—Development for the year ending August 31st, 1917, by the Teck-Hughes Gold Mines, Limited, was as follows:—

Shaft-sinking	200 feet.
Cross-cutting	775 "
Drifting	1,029 "
Winze-sinking	92 "
Stoping	2,495 "
Side-slicing	3,477 "

The mill treated 6,291 tons of an average value of $7.70, from March 24th, 1917, after the delivery of electric power, to September 1st, 1917. Proposed work

includes a supplementary steam plant for pumping and hoisting, steel shaft house and ore bins, addition to milling plant, and the erection of a number of dwellings for employees.

The main shaft is 400 feet deep, and a winze has been sunk to the 600-foot level.

The officers and directors of the company are: President, Chas. L. Denison, New York; vice-president, Robt. W. Pomeroy, Buffalo; secretary, A. D. Crooks, Toronto; treasurer, H. C. Clarke; Albert W. John ton and J. F. Thompson, New York.

In February, 1918, L. W. Ledyard was succeeded as resident superintendent by Robert E. Dye, of Cobalt. Eighty men were employed.

Tough-Oakes.—The Tough-Oakes Gold Mines, Limited, has an authorized capital of 600,000 shares, par value $5 each, and is the pioneer producer of the Kirkland Lake camp.

During the year ending December 31st, 1917, underground development was as follows:—

Drifting	2,398.5	feet
Cross-cutting	1,500	"
Raising	496	"
Sinking	105	"
Total	4,499.5	"

Ore stoped amounted to 31,692 tons, and in addition 5,310 tons were produced from development.

During November, 1917, Charles A. O'Connell resigned as manager, and was succeeded by D. H. Angus, of Cobalt. C. E. Rodgers, formerly of the Trethewey mine, is resident manager.

Temiskaming Kirkland.—Prospecting of the Hohenaur claim in Teck township was started in November, 1917, by the Temiskaming Kirkland Gold Mines, Limited. The plant owned by the Temiskaming Mining Company, Limited, at the North Dome mine in Porcupine, was shipped to Kirkland Lake, and before operations were closed in February, 1918, the vertical two-compartment shaft had been sunk to a depth of 40 feet. The plant included one Sullivan compressor, capacity 420 feet, one 80-h.p. return tubular boiler, one 40-h.p. locomotive type boiler, one 8 by 10 Lidgerwood hoist, one 5 by 7 Jenckes hoist, and one 120-volt, Allis-Chalmers generator for lighting purposes.

Work was in charge of William Cooper, of the Temiskaming Mining Company.

Wright-Hargreaves.—The Wright-Hargreaves Mines, Limited, employed an average of 35 men during the year on development work. No. 2 shaft was sunk from the 100-foot level to 320 feet, and No. 3 shaft, which at last report was 100 feet deep, was sunk to the 300-foot level.

A new Ingersoll-Rand compressor, capacity 1,165 cubic feet, was installed during the year.

The officers are: President, Oliver Cabana, Jr.; vice-president, Edwin Lang Miller; secretary-treasurer, Gerhard F. Miller; manager, Albert Wende.

United Kirkland.—United Kirkland Gold Mines, Limited, was organized in the summer of 1917 to develop the Ellis and Dodge claims in the township of Teck. A vertical shaft was sunk to a depth of 90 feet by the contractor, James Harkness, and 23 feet of cross-cutting done at the 90-foot level. Camps were erected and considerable surface trenching and prospecting performed to determine the strike and character of the vein system. Operations were suspended in December, 1917, shortly after the completion of the shaft contract.

The head office of the company is at Haileybury. H. A. Day is secretary-treasurer, and the directors are: W. G. Ellis, Swastika; H. A. Day, Haileybury: Levi Dodge, Englehart; Edward Kert, Smooth Rock Falls.

Associated Goldfields.—The Associated Goldfields Mining Company, Limited, formerly Goldfields, Limited, operated continuously throughout the year 1917. The head office is at 12 King Street East, Toronto, and the officers are: Managing director, George A. MacKay; secretary-treasurer, Howard Webb; mine superintendent, Frederick MacCoy.

In 1914 the claims of the Reddick Gold Mining Company, Limited, were purchased. These claims lie about nine miles northeast of the Goldfields mine. Very little development has been done on the Harris-Maxwell claims. A shaft, inclined at 30 degrees from the horizontal, has been sunk to a depth of 85 feet. From this point the shaft is vertical, and when visited in October, 1917, had been sunk to a depth of 360 feet below the tunnel level, or 425 feet from the surface.

Electric power developed at Raven Falls, 13 miles from the mine, is supplied on a 3-wire (three-phase) system, 13,200 volts, transformed at the mine to 550 volts.

The mill equipment at the Harris-Maxwell mine includes 30 Jenckes stamps and three jaw crushers. The Reddick mine shaft is 90 feet deep, and it was the intention of the management to develop this property during 1918. The plant was repaired and a new compressor, 2,000 cubic feet capacity, installed during the winter.

Porcupine

Ankerite.—The Ankerite Gold Mines, Limited, continued active development of their claims in Deloro township. Originally three claims, ME 60, 61 and 62, were being developed, but during the year the company acquired the Maidens-Macdonald property, under option to the La Rose Company till March, 1917, and also an additional claim south of the Maidens-Macdonald. When visited on January 31st, 1918, a vertical, 3-compartment shaft had been sunk to a depth of 230 feet, and 68 feet of cross-cutting done at the 200-foot level.

The sinking contract was let to the E. J. Longyear Company.

The Ankerite Gold Mines property is owned by the Coniagas Mines, Limited, of Cobalt.

Clifford E. C. Smith is manager of the company.

Davidson.—The Davidson Gold Mines, Limited, continued during the year development of their property near South Porcupine, on lot 2, in the fifth concession of Tisdale township. The main shaft is 312 feet deep with three working

levels. The mine was closed from June, 1917, till January 18th, 1918, and during this interval 500 feet of diamond-drilling was done, chiefly on the first and third levels. A ten-stamp mill was purchased from the Eureka mine, Wine Harbour, Nova Scotia, and erected near the main shaft. Early in 1918 the mill was put in operation. Recovery is made by straight amalgamation.

From May 1st to August 20th, 1917, C. E. Rodgers was manager, and during the balance of the year F. D. Henderson had charge of operations.

Dome.—The Dome Mines Company, Limited, has an authorized capitalization of $5,000,000, of which $4,000,000 has been issued.

The officers of the company are: J. R. DeLamar, president and treasurer; W. S. Edwards, first vice-president; C. D. Kaeding, second vice-president; H. P. DePencier, third vice-president; Alex. Fasken, secretary; Alfred H. Curtis, assistant-secretary and assistant-treasurer. The directors are: J. R. DeLamar, W. S. Edwards, Alex. Fasken, G. C. Miller, J. S. Wilson, A. H. Curtis, Andrew V. Stout, J. S. Bache. The head office of the company is at 36 Toronto Street, Toronto. C. D. Kaeding is general manager.

One dividend, amounting to $100,000, was paid in June, 1917.

The seventh annual report of the company, covering operations for the fiscal year ending March 31st, 1918, divides the year into two periods, one of eight months during which the mill was kept running, and four months when the mill was shut down and development work only was carried on. During the year a total of 258,917 tons was mined and hoisted; of this, 247,000 tons was ore which was sent to the mill and treated, and 11,917 tons was waste which was dumped on the surface. In addition to the above 101,352 tons was mined and remained in shrinkage stopes. The 247,000 tons of ore treated in the mill yielded bullion worth $1,030,758.30, the average yield per ton being $4.173.

On December 1st, 1917, operations in the mill and mine were discontinued, and the main shaft equipped for sinking. On May 20th, 1918, the shaft had reached a depth of 1,200 feet, sinking from the 850-foot level. A large ore and waste pocket and loading station were cut at the 960-foot levels, and stations established at the 1,000 and 1,150-foot levels. Ore reserves as at March 31st, 1918, are estimated at 1,950,000 tons at $5.10, or $9,945,000.

A summary of the development done during the year ending March 31st, 1918, is as follows:—

Level	Drifts	Cross-cuts	Raises	Box Holes	Shafts	Stations	Pockets	Total	Diamond Drilling	Total
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
1st...	....	136.5	....	......	....	....	....	136.5	....	136.5
3rd...	253.0	......	....	21.0	....	....	....	274.0	1,390.5	1,664.5
4th...	....	......	....	......	....	....	....	....	....	....
5th...	178.5	12.0	111.0	93.5	....	....	....	390.0	1,416.0	1,806.0
6th...	262.5	254.0	206.5	103.5	....	....	....	826.5	967.0	1,793.5
7th...	532.5	883.5	218.5	346.0	....	....	....	1,980.5	1,710.5	3,691.0
8th...	1,370.5	663.0	61.0	......	....	....	66.0	2,160.5	1,848.5	4,009.0
9th...	....	......	....	......	....	22.0	....	22.0	....	22.0
Shaft.	....	......	....	......	178.0	....	....	178.0	....	178.0
Totals	2,592.0	1,949.0	497.0	564.0	178.0	22.0	66.0	5,968.0	7,332.5	13,300.5

During the early part of the year, work was carried on in the Dome Extension, the No. 609 drift being carried ahead a total distance of 29.5 ft. to a point 240.5 ft. across the dividing line of the two properties, where 17.5 ft. of cross-cutting and 26 ft. of raising was done to make a drill station. A total of 1,755 ft. of diamond-drilling was done from underground, mostly toward the ore located south of the porphyry mentioned in the sixth annual report of the company. Four holes totalling 975.5 feet were drilled on the hill to the north of the Dome Extension shaft, but no indication of ore or payable zones was obtained from this work.

Dome Lake.—The Dome Lake Mining and Milling Company, Limited, operated their mine and mill continuously during 1917. Underground development was as follows:—

Drifting	927 feet.
Cross-cutting	304 "
Raising	45 "
Winzing	184 "
Diamond-drilling	3,904 "

The mill treated 16,388 tons during the year, having a gold value of $68,213.99 from which was recovered in bullion $45,029.56, representing an extraction of 66 per cent.

The cost of milling was $1.857 per ton and of mining exploration and development $4.957 per ton.

The 66 per cent. extraction was made by plate amalgamation only.

The officers are: President, George Taylor; vice-president, A. A. McKelvie; directors, T. McCamus, C. L. Sherrill, S. S. Ritchie, F. L. Bapst, S. J. Dark; secretary-treasurer, F. L. Hutchinson; consulting engineer, Douglas A. Mutch; manager, R. T. Regnell.

Hayden.—The Hayden mine, in Ogden township, operated by the Hayden Gold Mines, Limited, was closed most of the year. A vertical two-compartment shaft has been sunk to a depth of 375 feet, with working levels at the 100, 200, and 300-foot levels. The mine closed in May, 1917, and work after that date was confined to diamond-drilling.

W. H. Hayden, 101 North Street, Batavia, N.Y., is president of the company, and W. D. Spaulding, 509 Brisbon Building, Buffalo, N.Y., is secretary-treasurer. William Shovel was mine manager.

Hollinger Consolidated.—Hollinger Consolidated Gold Mines, Limited, has an authorized capital of $25,000,000, divided into 5,000,000 shares of par value $5 each. Outstanding shares January 1st, 1918, amounted to 4,920,000.

The officers are: President, Noah A. Timmins, Montreal; secretary-treasurer, David A. Dunlap, Toronto; managing director, P. A. Robbins; directors, Noah A. Timmins, L. H. Timmins, David A. Dunlap, John B. Holden, P. A. Robbins, and Jules R. Timmins. John McMartin, Cornwall, formerly vice-president and one of the founders of the company, died in April, 1918.

The following statistics regarding the operations for the year 1917 are taken from the company's seventh annual report:—

During the year 508,139 tons of ore were milled, yielding $4,261,938.72; $738,000 was paid in dividends. $1,202,854.97 was paid out for labour and $1,003,332.57 for stores. Total costs, including mining, milling and general charges, amounted to $4,439 per ton of ore milled. The average value per ton of ore milled was $8.67. Mine development amounted to 29,696 feet, as follows: —

Levels	Shafts	Drifts	Cross-cuts	Raises	Diamond Drilling	Timbering	
						Shafts and Winzes	Stopes
	ft.	ft.	ft.	ft.	ft.	ft.	ft.
100	....	....	....	192	129	....	521
200	....	2,929	2,778	342	3,200	....	2,177
300	....	2,146	1,093	828	1,288	....	1,660
425	125	2,908	3,927	1,152	1,414	175	3,043
550	232	1,716	829	233	947	233	1,282
675	221	1,555	986	345	1,022	218	120
800	66	1,451	2,489	265	24	185	30
950	....	33	42	....	....	....	6
1,100	....	112	184	....	....	....	....
1,250	....	124	393	....	....	....	....
Totals....	644	12,974	12,721	3,357	8,024	811	8,839

The stoping record for the year is shown in the following table:—

Levels	Broken ore in stopes Jan. 1st, 1917	Ore broken during 1917	Ore removed during 1917	Broken ore in stopes Dec. 31, 1917
	Tons	Tons	Tons	Tons
100	4,291	....	3,026	1,265
200	72,292	105,479	84,047	94,354
300	36,663	143,555	157,966	22,252
425	82,713	162,148	129,965	114,896
550	10,590	37,908	24,917	23,581
675	....	313	313	....
800	....	49	49	....
Totals	207,179	449,452	400,283	256,348

The estimated gross value of ore reserves at December 31st, 1917, amounted to $40,231,435. The average number of men employed during the year was 1,045.

Keora.—The Keora mine is located on lot 6, in the Sixth Concession of the township of Whitney, and is owned by the Porcupine Keora Mining Company, Limited. Development consists of two shafts, one vertical 120 feet deep, and one incline 60 feet deep. Work during 1917 was confined to diamond-drilling, 2,312 feet being completed.

A. J. Brandt, South Porcupine, is general manager, and William B. Gunton, 304 Confederation Life Building, Toronto, secretary-treasurer.

McIntyre.—During the year ending June 30th, 1918, the McIntyre Porcupine Mines, Limited, milled 178,327 tons of ore, with a gold production of $1,717,309.88.

Underground development for the 12 months' period is shown in the following table:—

—	Pockets	Stations	Shafts	Sumps	Drifts	Cross-cuts	Raises	Winzes	Total	Diamond Drilling
July 1, 1917 to June 30, 1918	75.0	92.9	423.5	9.6	4,686.1	1,196.5	346.0	63.0	6,892.6	6,987.0
Total prior to July 1, 1917	....	997.1	4,786.6	131.7	22,540.0	11,304.8	4,497.4	393.2	44,651.0	19.920.2
Total to date..	75.0	1,090.0	5,210.1	141.3	27,226.1	12,501.3	4,843.4	456.2	51,543.6	26,907.2

The Jupiter shaft was completed to the 1,000-foot level, and the drift on this level to connect the main shaft with the Jupiter was driven 1,300 feet. At this point, about 1,000 feet from the Jupiter shaft, in the quartz-porphyry formation, heavy water was encountered and the drift was abandoned until an adequate pumping plant could be installed.

From the Jupiter shaft at the 475-foot and 1,000-foot levels, cross-cuts have been driven into the Plenaurum ground. In July, 1918, the cross-cut at the 1,000-foot level had been driven 250 feet in Plenaurum ground, and it was the intention of the management to diamond-drill from both the 475 and 1,000-foot levels. Two new electrically driven hoists were installed during the year. At No. 5 shaft, a Nordberg was ready for operation in July, 1918, and the headframe raised ten feet to permit of greater clearance and allow for installation of an 84-inch sheave. At the Jupiter shaft a large Webster, Camp and Lane hoist has been installed.

In the mill a duplicate clarification system has been added to the equipment.

A modern dry house to accommodate 250 men has been built at No. 5 shaft, and electric haulage installed on the 1,000-foot level.

The officers of the company are: President, J. P. Bickell; vice-president, Sir Henry M. Pellatt; secretary-treasurer, M. P. Van der Voort, all of Toronto; directors, W. J. Sheppard, Waubaushene, J. B. Tudhope, Orillia; E. F. B. Johnston, Toronto; H. D. Symmes, Niagara Falls; general manager, R. J. Ennis; mine superintendent, J. E. McAllister; mill superintendent, A. Dorfman.

An average of 332 men was employed during the year.

Newray.—The Newray Mines, Limited, operating the Rea property in Tisdale township continued development work chiefly on the 400-foot level, till November 1st, 1917. During this period the cross-cut on the 400-foot level was driven 1,150 feet in a southeasterly direction. The property was then optioned to the Porcupine Crown Mines, Limited, and work was continued by them until February 1st, 1918. The Porcupine Crown Company did about 700 feet of diamond-drilling and 600 feet of drifting, and abandoned their option.

On May 1st, 1918, the McIntyre Porcupine Mines, Limited, acquired an option and began sampling operations. Due to labour conditions, underground work was stopped on June 20th, 1918. The mill was operated for three months during the year by the Newray Mines Company, and from June 24th, 1918, to July 20th, 1918, by the McIntyre Company.

The officers of the Newray company are: President, Dr. Bixby, Buffalo, N.Y.; vice-president, Henry Tudor, New York; secretary-treasurer, J. E. Day, Toronto; managing director, C. P. Charlebois.

Night Hawk.—About eight miles south of Connaught station, on the Porcupine branch of the T. & N.O. railway, in the township of Cody, the Porcupine Night Hawk Mining Company, Limited, continued the development and prospecting of their claims on Night Hawk lake. A vertical shaft has been sunk to a depth of 90 feet, and 380 feet of cross-cutting and drifting done at the bottom level. During the year 500 feet of diamond-drilling was completed. The plant includes one compressor, capacity 300 cubic feet, one Jenckes 5 by 7 hoist, 2 locomotive boilers, 60 and 80-h.p.; blacksmith shop and camps. Work was carried on continuously during 1917 till October 1st, when operations were suspended because of high operating costs and shortage of labour.

The officers are: President, O. B. Wilcox, New York; treasurer, J. H. Black, Toronto: directors, Charles Auer, Timmins, and F. D. Forbush, Detroit. William Watson was mine manager.

North Davidson.—The North Davidson Gold Mines, Limited, did 1,500 feet of diamond-drilling on their property on lot 3, in the sixth concession of Tisdale township.

A wagon road was also partly completed between the Davidson mine and the North Davidson claim.

The officers are: President, R. T. Jeffrey; managing director, L. G. Harris, Royal Bank Building, Toronto.

F. D. Henderson was in charge of operations at the property, and the company planned to sink a 300-foot shaft during the summer of 1918.

McEnaney.—McEnaney Gold Mines, Limited, operated at intervals during the year. The property was formerly known as the Hollinger Reserve, and is located on lots 2 and 3, in the fifth concession of Ogden township. Development during 1917 included 250 feet of drifting and cross-cutting on the 100-foot level, sinking winze east of the shaft from 300-foot level to 440-foot level, and raising from the 200 to 100-foot level. The mine was de-watered in January, 1917, and operations were suspended in September, 1917. Work was resumed on November 1st and again closed on February 12th, 1918.

The late Bernard McEnaney was president of the company and principal owner of the property. William Sixt was mine manager.

Porcupine V.N.T.—During 1917, underground operations by the Porcupine V.N.T. Gold Mines, Limited, were confined to the North Thompson section, from which 27,805 tons of ore were mined. No ore was produced from the Vipond section, operations there being postponed until the connection has been completed

between the North Thompson and Vipond shafts at the 600-foot level, when the underground operations will be centralized at one shaft. The mill on the Vipond property was run continuously, producing 19,360.27 ounces of bullion, worth $205,914.29. A new electrically driven Ingersoll-Rand compressor, capacity 7,050 cubic feet, was installed. A new transformer station was built on the North Thompson section of the property of sufficient capacity for all the power that will be required in the future. During the early part of the year operations were greatly hindered by the uncertain labour conditions.

The company has an authorized capital of 3,000,000 shares of par value $1.00.

The officers are: President, H. H. Ward, New York; vice-presidents, F. H. Hamilton and P. W. Furber, London, England; secretary-treasurer, R. J. Ward, New York; directors, R. T. Shillington, Haileybury; James J. Hill, St. Paul; D. J. Jackson, New York; Henry Pellatt, Toronto. N. J. Evered, Box 189, Timmins, is general manager, and the head office of the company is 50, East 42nd Street, New York.

Porcupine-Crown.—Porcupine-Crown Mines, Limited, has an authorized capital of 2,000,000 shares of $1 par value each. The officers are: President, John W. Carson; first vice-president, William I. Gear; 2nd vice-president, James G. Ross; secretary-treasurer, James Cooper, all of Montreal. The directors include the above officers and C. A. Smart, J. W. Ross, A. G. Gardner, F. S. Meighen, Ziba Gallagher, and R. W. Reford. S. W. Cohen is general manager and Maurice W. Summerhayes, manager.

During 1917, 32,722 tons of ore were milled of an average value of $10.97. The net value of the production after deducting charges was $363,793.34.

The underground development during the year was practically all done below the 500-foot level. Ore reserves at the close of the year were estimated to be about 60,000 tons.

No dividends were paid after July 1st, owing to curtailment of production. For the first half of the year dividends amounting to $120,000 were paid, bringing the total amount paid in dividends to date $840,000.

Premier.—Porcupine Premier Gold Mines, Limited, operated their mine on lot 6, in the sixth concession of Deloro township, for the first half of the year only.

No. 1 shaft was completed to the 200-foot level, and a cross-cut driven to the south 170 feet, at which point a promising vein was encountered. No. 2 shaft was raised from the 100-foot level to the 60-foot, giving an auxiliary exit from the 100-foot level to the surface.

The officers are: President, George W. Field; secretary, Frank J. Wright, both of 19, Congress Street, Boston, Mass.; general manager, A. S. Fuller, South Porcupine. B. M. Walton is mine superintendent.

Rypan.—The Rypan Porcupine Mines, Limited, began work on their four claims in Deloro township on May 15th, 1917. Prospecting by surface trenching and open-cuts on the outcrops continued till August 23rd, 1917, when operations were suspended.

The officers are: President, John Patterson, Toronto; secretary, J. W. Ryder, Toronto. C. L. Heath was in charge of the development.

Schumacher.—The Schumacher Gold Mines, Limited, has an authorized capital of 2,000,000 shares of par value $1 each.

The officers are: President, F. W. Schumacher; vice-president, F. L. Culver; secretary-treasurer, J. Y. Murdoch; manager, T. J. Harwood.

For the year ending March 31st, 1918, the following development was performed:—

Drifting	1,420	feet.
Cross-cutting	1,096	"
Raising	178	"
Diamond-drilling	705	"
Stoping	36,446	tons.

Shortage of labour resulted in the mine and mill being closed from June 26th to August 20th, 1917. During the remaining ten months of the year the mill treated 39,822 tons of ore, with a production of bullion valued at $202,387.35. Extensive additions and improvements were made in the mill, involving an expenditure of $39,554.90; additions to mining plant cost $13,090.59.

Stanley A. Wookey resigned as manager to enlist with the Canadian Engineers, and was succeeded by T. J. Harwood, formerly of La Rose mine.

West Dome.—West Dome Consolidated Mines, Limited, worked continuously throughout the year. Total development at the several shafts to March 15th, 1918, was as follows:—

No. 1 or main shaft, 358 feet deep on incline;
100-foot level, cross-cutting 645 feet;
300-foot level, cross-cutting 1,457 feet, drifting 2,352 feet.
No. 3 shaft, 115 feet deep, vertical; cross-cutting 300 feet; drifting 180 feet.
No. 4 shaft, 98 feet deep, vertical; drifting 15 feet;
No. 2 shaft, 30 feet deep, vertical;
Central shaft, 35 feet deep, vertical.

During 1917, work was practically confined to development at the 300-foot level of the main shaft, and the sinking of the new central shaft to a depth of 35 feet. In the spring of 1918 stoping was commenced on the 300-foot level, main shaft, and about 600 tons were broken. Of this amount 300 tons were hauled to the Dome Lake mill, during the month of May, 1918, and a test mill-run made.

The officers are: President, Henry Pellatt; secretary-treasurer, C. H. Manaton, Traders' Bank Building, Toronto; consulting engineer, Frank G. Stevens, Toronto. The manager, W. J. Trethewey, was succeeded in February, 1918, by Frank Hamilton, formerly mine captain.

Thirty-five men were employed during the year.

Whelpdale.—The Whelpdale mine is situated near Timmins, and comprises the Whelpdale veteran claim of 160 acres, being the north half of lot 11, in the third concession of Tisdale township. Development in the early stages was carried on by the Porcupine Whelpdale Mining Syndicate. Late in 1917 the Porcupine Whelpdale Mines, Limited, was organized, with the following officers: President, J. A. Kilpatrick, Toronto; vice-president, Frank P. Jones, Montreal; secretary-treasurer, B. J. Simons, Toronto; directors, George Tamblyn, R. M. Gray, J. O.

Gadsby, S. B. Dawson, C. M. Dineen, R. L. Marks, all of Toronto. The head office address is 910 and 911 Royal Bank Building, Toronto, and H. Max Guenther, Box 391, Timmins, is manager. When inspected on February 13th, 1918, a vertical shaft had been sunk to a depth of 114 feet, with a station at the 100-foot level. About 30 feet of cross-cutting had been driven at this level.

Miscellaneous Mines

Alexo Nickel.—During 1917, the Alexo Mining Company, Limited, shipped 6,003.3 tons of nickel ore to the Coniston smelter of the Mond Nickel Company. The company own five claims in the townships of Clergue and Dundonald, the chief development being in the N.E. quarter of S. half of lot 1, concession III., township of Clergue, about two miles from Porquis Junction, on the Timmins branch of the T. & N. O. railway.

The officers of the company are: President, G. F. Hanning, Toronto; vice-president, Major E. F. Pullen, France; treasurer, H. N. Roberts; director, Capt. F. Pullen; manager, William Anderson.

During 1917 the main shaft was sunk from the 125-foot level to a depth of 326 feet, and about 70 feet of drifting done at the bottom level. All the production came from the 125-foot level.

The plant consists of one locomotive type 60-h.p. boiler, one upright 30-h.p. boiler, one Canadian Westinghouse compressor, and one 6 by 8 Jenckes hoist.

The decreased production during the year was due to car shortage.

Premier Langmuir Barite.—The Premier Langmuir Mines, Limited, own seven patented claims in the township of Langmuir, on the east branch of the Night Hawk river. By water route the property is 30 miles from Connaught station, on the T. & N. O. railway.

The geology of this deposit has been fully described in previous reports of the Bureau of Mines, and it is the only mine in the Province producing barite on a commercial scale. A vein of barite, varying from 5 to 10 feet in width, has been traced for a distance of 1,000 feet on the property. A tunnel, driven on the vein for a distance of 100 feet, shows native silver in several places. When inspected on February 1st, 1918, a shaft had been sunk at the portal of the tunnel to a depth of 55 feet, and it was the intention of the management to sink to the 120-foot level and develop the ore body there.

The officers are: President, J. A. McIntosh, 454 Markham Street, Toronto; secretary-treasurer, J. B. Aikenhead, London, Ontario; mine manager, Charles W. Dalby.

An average of 17 men was employed during the year.

Colorado Ontario.—In the spring of 1918, the Colorado Ontario Development Company began active exploration and development of the Otisse and Robb gold claims in Powell township. A wagon road was built from Elk Lake to the claims, a distance of 30 miles, and supplies were taken in for the summer. Diamond-drilling started May 21st, 1918.

Walter J. Boland, No. 2 Toronto Street, Toronto, is secretary-treasurer of the company, and T. J. Flynn, superintendent.

Cobalt Silver Mines

Adanac.—The Adanac Silver Mines, Limited, worked continuously throughout the year on their property in southeast Coleman, formerly known as Pan Silver.

Work was practically confined to the 310-foot level, cross-cutting north to encounter veins discovered by diamond-drilling. In April, 1918, the cross-cut heading was 500 feet from the shaft. Developments proved satisfactory to the owners and will be continued during 1918.

The officers are: President, R. A. Cartwright; vice-president, E. N. Campbell; treasurer and managing director, Morgan R. Cartwright, Haileybury; secretary, James Aitchison, Toronto; directors, R. A. Cartwright, E. N. Campbell, Morgan B. Cartwright, J. L. Wheeler, Marion, South Carolina, and A. B. Hind.

Aladdin.—The Aladdin Cobalt Company, Limited, operated continuously throughout the year. Work was confined to No. 4 shaft of the Chambers-Ferland, west of the railway, and the discovery of several promising ore shoots materially added to the production.

Development during the year was as follows:—

Drifting and cross-cutting	2,323	feet.
Sinking	113	"
Stoping	3,970	cubic yards.

The greatest production came from stoping operations, on an extension of No. 15 vein, 275-foot level.

The ore was milled at the Northern Customs concentrator.

The officers are: President, Major Conrad Jorgenson; secretary-treasurer, F. F. Fuller; directors, Major Charles Gold, Dennis Herbert, H. B. Sedgwick, all of London, England; Canadian advisory board, Charles A. Richardson, Arthur Ferland, and R. T. Shillington, all of Haileybury; Alex Fasken, Toronto, secretary.

Head office for Canada, Excelsior Life Building, Toronto. J. A. McVichie, Cobalt, is manager of the company.

Beaver.—Beaver Consolidated Mines, Limited, has an authorized capital of 2,000,000 shares, of par value $1 each. The officers are: F. L. Culver, President and general manager; F. C. Finkenstaedt, vice-president; H. E. Tremain, secretary-treasurer. The directors are: F. L. Culver, F. C. Finkenstaedt, F. L. Lovelace, Wm. T. Mason, Wm. E. Stevenson, H. E. Tremain, J. H. Black. Head office, Lumsden Building, Toronto. The following is a synopsis of development during the year ending February 28th, 1918:—

Drifting	2,245.1	feet.
Cross-cutting	1,453.3	"
Sinking	75.1	"
Raising	1,178.4	"
Total	4,951.9	"
Stoping	4,187.7	cubic yards.

Most of the work during the year was done on No. 2 and No. 3 vein systems. The annual report of the company states that in No. 2 vein system a body of ore has been opened up which has greatly augmented the ore reserves of the mine. Regarding development on the 1,600-foot level, the annual report states as follows:—

"Milling values have been proven for a distance of 67 feet below the 1,600-foot level by sinking a winze on the vein. Anticipating that the highest values would be found at or near the contact between the diabase and Keewatin formations, the vein was followed up by a raise for 147 feet above the 1,600-foot level and milling values established for this distance. However, not having reached the contact on account of the dip of the sill, and the expense of raising beyond this point, together with the danger attached thereto being very great, work was discontinued in this raise and a cross-cut is being driven from the main shaft on the 1,400-foot level to intercept the vein in hopes of locating the contact at or about this point."

The total production for the year amounted to 372,973 ounces of silver.

The Beaver Auxiliary property was not worked during the year.

Buffalo.—The Buffalo Mines, Limited, operated continuously during the year. Underground operations were as follows:—

——	Raising	Drifting	Stoping
	ft.	ft.	cubic ft.
1st Level	....	265	200,500
2nd "	295	375	251,700
3rd "	20	140	....
Total	315	780	452,200

The tonnage broken in raising was 1,312 tons, in drifting 2,275 tons, and in stoping 37,683 tons. Total tonnage broken 41,270, less waste rock 800 tons. Net ore tonnage, 40,470 tons.

The above figures are for the fiscal year ending April 30th, 1918. For the eleven-month period ending March 31st, 1918, there were recovered in jig and table concentrates, 280,790 ounces of silver, and in flotation concentrates from the treatment of 82,328 tons of sand, 356,361 ounces of silver, making a total of 637,151 ounces. The Holt-Dern furnace installation for the treatment of flotation concentrates was abandoned early in the year, and the concentrates were thereafter shipped to Denver.

The officers are: President, Charles L. Denison, New York; vice-president, Robt. W. Pomeroy, Buffalo, N.Y.; 2nd vice-president, Harland B. Crandall, New York; secretary-treasurer, George C. Miller, Buffalo; director, Albert W. Johnston, New York. Tom R. Jones, Cobalt, is general superintendent.

Casey-Cobalt.—The Casey-Cobalt Silver Mining Company, Limited, continued active development of their mine in Casey township throughout the year. Until March 5th, 1917, work was confined to de-watering and repairing No. 6 shaft, and reconstructing the surface plant destroyed in the fire of August 22nd, 1916. The following progress was made underground:—

Stoping	10,932 cubic feet.
Development	774 lineal feet.
Exploration	1,723 " "

A concentrating mill was built during the winter of 1917-18 and put in operation in March, 1918.

The average number of men employed from March, 1917, to the close of the year was 59.

The officers are: President, W. R. P. Parker; vice-president, J. P. Watson; secretary, W. W. Perry, all of Toronto. Head office, 1,514 Traders' Bank Building, Toronto; manager, John W. Shaw, New Liskeard.

Casey Mountain.—The syndicate operating the Casey Mountain Mining Company, Limited, on lot 6, in the second concession of the township of Casey, continued development during the greater part of 1917. A cross-cut on the 345-foot level was driven about 90 feet, when operations were suspended to permit of diamond-drilling underground.

The officers of the operating syndicate are: President, J. D. Martin, Regina; vice-president, H. M. Richardson, Fort Qu'Appelle; secretary-treasurer, A. J. Cameron, Regina; directors, Geo. Speers, Regina; A. Cunningham, Moose Jaw; manager, R. G. Williamson, Judge P.O., Ontario.

The Toronto office is 115 Stair Building, Toronto, and Wm. A. Staples is secretary-treasurer; R. G. Williamson, president, and James Thompson, Havelock, vice-president.

Coniagas.—The Coniagas Mines, Limited, has an authorized capital of 800,000 shares of par value $5 each. The officers are: President and general manager, R. W. Leonard; vice-president, Alex. Longwell; secretary-treasurer, J. J. Mackan; superintendent, Fraser D. Reid. Included with the above officers on the board of directors are: R. P. Rogers, F. J. Bishop, R. L. Peek, and W. D. Woodruff. Head office is at St. Catharines, Ontario.

The total distribution in dividends to the shareholders to date aggregates $8,740,000.

For the year ending October 31st, 1917, underground development was confined to the following of small veins and stringers on all levels, exploring the contact on the eastern boundary and driving numerous cross-cuts through unexplored areas. This work disclosed some patches of high-grade and a considerable tonnage of low-grade milling ore. The further discovery of ore shoots of any importance is considered unlikely, as practically all the mine has been prospected.

Statistics of mine development are:—

——	Total to Oct. 31, 1917	Total to Oct. 31, 1916	Work during 1916-17
	ft.	ft.	ft.
Shaft-sinking	879	875	4
Drifting	18,834	17,611	1,223
Cross-cutting	10,295	9,527	768
Winzing	632	632	.....
Raising	1,396	1,067	329
Total	32,036	29,712	2,324

Total ounces of silver shipped to Thorold during the year, 1,344,267.43.

The concentrating mill treated 60,929 tons, or an average of 3.07 tons per stamp per 24 hours.

The Callow flotation plant was put in operation February 6, 1917, and has effected a material reduction in the value of the mill tailings. Ore reserves at October 31st, 1917, were estimated to contain 4,487,590 ounces of silver.

An average of 110 men was employed during the year.

Crown Reserve.—The Crown Reserve Mining Company, Limited, has an authorized capital of 2,000,000 shares, of a par value of $1 each. The officers and directors are the same as for the Porcupine Crown Mines, Limited. S. W. Cohen is general manager and J. H. Stewart, mine superintendent.

During the year 1917 the production amounted to 329,670 ounces, making the total production of the mine 19,690,676 ounces.

Underground development was as follows:—

Sinking and raising	354 feet.
Drifting	1,849 "
Cross-cutting	595 "

At the Cochrane mine 938 feet of development was driven at the 550-foot level, practically all on the vein. Good ore was encountered in several places in this development, and some spots of high-grade were found. The work demonstrated that the probabilities of opening up ore of commercial value were limited, and work was discontinued.

The Drummond Fraction was operated only part of the year, owing to severe weather and shortage of labour.

About 400 feet of development was done on the Silver Leaf lease, at the 300-foot level on the extension of the north vein of the Crown Reserve mine. Milling ore of fair grade was opened up.

Dickson Creek.—The Dickson Creek Mining Company, Limited, operated the first two months of the year on their property, lots 9 and 10 in the fifth concession of Bucke township. Work was confined to shaft-sinking. In March, 1918, operations were resumed, and on May 21st, 1918, the shaft had been sunk to a depth of 160 feet.

The company is composed of London, England, capitalists. H. Holland-Hurst, Haileybury, is manager.

Dominion.—The Dominion Reduction Company continued to operate the Dominion mine, formerly known as the Nova Scotia. Work—wall-slashing for mill rock—was confined chiefly to the main or Bilsky vein. At No. 3 shaft, 150 feet of drifting was done at the 75-foot level.

Fifteen men were employed during the year.

Dominion Reduction.—The 40-stamp custom mill operated by the Dominion Reduction Company worked continuously throughout the year. Ore, treated as in previous years, was supplied chiefly by the Kerr Lake and Crown Reserve mines, with small tonnages from the Chambers-Ferland and Hargrave. For the fiscal year ending September 30th, 1917, 56,558 tons of ore were milled, having an

average silver content per ton of 24.24 ounces, total silver produced being 1,370,861 ounces.

The Holt-Dern equipment for treating flotation concentrates was increased to four furnaces. The roasted concentrates are leached with an acid brine solution and the silver precipitated on copper.

The officers are: President, D. M. Steindler, New York; vice-president, Mortimer B. Davis, Montreal; secretary and general manager, Eugene L. Steindler, Cobalt; assistant manager, P. L. Blodgett, Cobalt; mine superintendent, H. R. Bischoff, Cobalt.

Edwards and Wright.—Messrs. Edwards and Wright, Toronto, acquired the Green-Meehan and Red Rock properties by purchase, and during the summer of 1917 the shafts were de-watered and the workings thoroughly sampled.

At the Green-Meehan the shaft is 200 feet deep and has been further developed by a winze 45 feet deep. In April, 1918, a promising vein was encountered on the 245-foot winze level.

The dump at the Green-Meehan shaft is being milled at the Northern Customs concentrator, and drifting on the new vein is in progress towards the Red Rock workings.

John Edwards is in charge of operations with E. J. McMillan as mine captain. Twenty-five men are employed.

Genesee.—The Genesee Mining Company, Limited, worked continuously throughout the year, on their lease from the United States Cobalt Mining Company, of the southwest quarter of the south half of lot 9, concession 1, township of Bucke. At the close of the year the shaft had been sunk to a depth of 572 feet, and stations cut at the 350, 450, 500 and 550-foot levels; about 400 feet of cross-cutting and drifting had been done on the 500-foot level.

The officers are: President, Ralph H. Gorsline, Rochester, N.Y.; secretary-treasurer, Alex. Russell, Rochester, N.Y.; A. A. Amos, Cobalt; manager, Leonard F. Steenman, Cobalt.

Gifford.—The Gifford Cobalt Silver Mining Company resumed operations on their property adjoining the Beaver in August, 1917. The shaft is 200 feet deep, and at the close of the year a winze located 400 feet northeast of the shaft had been sunk to a depth of 150 feet, and 100 feet of cross-cutting done at the bottom level.

Difficulty was experienced in handling the water, and early in 1918 the mine was closed.

Frank B. Mosure of Toronto was manager, and J. Bedford mine captain; employing 12 men.

Hargrave.—The Hargrave Silver Mines, Limited, operated continuously throughout the year. Following is a summary of the underground work done:—

Drifting	421	feet.
Cross-cutting	235	"
Raising	664	"
Sinking	124	"
Total	1,444	"

Ore hoisted amounted to 2,556 tons, yielding 75,202.14 ounces of silver, of a gross value of $52,324.02. Operating expenses amounted to $53,254.64.

The officers are: President, James A. Aitchison; secretary-treasurer, Geo. H. Sedgwick; manager, J. T. Shaw. Head office, Excelsior Life Building, Toronto.

Hudson Bay.—The Hudson Bay Mines, Limited, operated their mine and mill continuously during the year. Underground development was as follows:—

Drifting	655.7 feet.
Cross-cutting	359.7 "
Raising	637 "

This work opened up several small veins; one known as the "Branch vein" was picked up on the first level west of the shaft and stoped on for a length of 140 feet.

During the year the mine produced 261,887.09 ounces at a total cost of production, including selling cost, of 43.57 cents per ounce. The mill treated 18,247 tons of 17.3-ounce ore, and recovered 262,863.7 ounces of silver, equivalent to an extraction of 83.2 per cent. The cost of treatment was $2.09 per ton or 14.5 cents per ounce recovered.

No work was done at No. 2 mine, or on the Gowganda and Kirkland Lake claims owned by the company.

The officers are: President, George Taylor; vice-president, A. A. McKelvie; secretary-treasurer, F. L. Hutchinson; manager, Douglas A. Mutch; directors, S. S. Ritchie, T. McCamus, William H. Kinch, C. L. Sherrill, F. L. Bapst.

Kerr Lake.—The Kerr Lake Mining Company has an authorized capitalization of $3,000,000, divided into 600,000 shares of par value $5 each.

The officers are: President, Adolph Lewisohn, New York; vice-president, Sam A. Lewisohn, New York; secretary-treasurer, E. H. Westlake, New York; mine manager, H. A. Kee, Cobalt.

Underground development for the fiscal year ending August 31st, 1917, was as follows:—

Drifting	1,268 feet.
Cross-cutting	588 "
Raising	1,197 "
Sinking	52 "

Total development, 3,105 feet; total stoping, 34,597 square feet, total side-cutting, 114 square feet.

The gross production from all ores amounted to 2,551,345.94 ounces of silver and 89,453.63 pounds of cobalt. The ore reserves at the close of the year were estimated to contain 3,120,400 ounces of silver.

Production from the Drummond Fraction amounted to 67,112 ounces, taken chiefly from a smaltite vein which is the easterly extension of the Fleming vein, also from a vein which is the westerly extension of the Comet vein. Work on the Drummond was discontinued January 31st, 1917.

The costs of production per ounce were as follows:—

Mining and development	11.65 cents.
Shipment and treatment	14.52 "
Administration and general	00.58 "
Total	26.75

La Rose.—The capital stock of La Rose Mines, Limited, was reduced by letters patent dated November 12th, 1917, from the sum of $6,000,000, divided into 6,000,000 shares of $1.00 each, to the sum of $1,500,000 divided into 1,500,000 shares of $1.00 each. Pursuant to a resolution passed by the stockholders of La Rose Consolidated Mines Company on December 10th, 1917, all the liabilities of the Consolidated Company were assumed by La Rose Mines, Limited, and all the assets of the Consolidated Company except 1,500,000 shares of La Rose Mines stock, are now vested in La Rose Mines, Limited. The Consolidated Company will be dissolved.

The officers are: President, D. Lorne McGibbon; vice-president, Shirley Ogilvie; secretary-treasurer, S. J. LeHuray; general manager, G. C. Bateman. The directors are: D. Lorne McGibbon, Edwin Hanson, E. W. Nesbitt, W. A. Black, Victor E. Mitchell, K.C., Wm. Dobell, Shirley Ogilvie, David Fasken, S. J. LeHuray. Head office, 260 St. James Street, Montreal.

Development work during the year was as follows:—

——	Trenches	Shafts	Drifts	Cross-cuts	Raises	Stopes
	ft.	ft.	ft.	ft.	ft.	cu. yds.
La Rose........	88	....	934.5	304	270	334
Lawson	60	....	115.5	467.5	42	221
Violet	....	382.5	....	....	....	....
	148	382.5	1,050	771.5	312	555

The total silver obtained from all sources was 478,639 ounces, having a gross value of $371,583.84, and produced at a total cost of $300,211.42, the profit on which was $71,372.42. The average price received for silver during the year was 82.94 cents. No work was done on the Princess, Fisher-Eplett, and University mines. A new shaft was sunk on the Violet, which adjoins the O'Brien on the east. The Keewatin-diabase contact was cut at 383 feet, and the shaft continued to the 425-foot level. Cross-cutting encountered veins showing considerable values.

Exploration work was done on two gold properties held under option, but results were not encouraging, and the options were dropped.

McKinley-Darragh-Savage.—During the year 1917, the McKinley-Darragh-Savage Mines of Cobalt, Limited, recovered 908,756 ounces of silver from their mining and milling operations, bringing the total production up to 17,323,102 ounces. The average price received for silver during the year was 83.20 cents per ounce, and the total costs 57.09 cents. The ore reserves on January 1st, 1918, were estimated to contain 1,076,182 ounces.

The tailing mill was not operated, due to non-delivery of grinding machinery. Underground development was as follows:—

Cross-cutting	1,876.5	feet.
Drifting	2,408.0	"
Raising	374.5	"
Shaft-sinking	14.5	"
Winzing	12.0	"
Total	4,685.5	"

The mill treated 68,142 tons of ore, yielding a total recovery of 796,298 ounces.

The officers are: President, J. R. L. Starr, Toronto; vice-president, Thos. W. Finucane, Rochester; treasurer, Harper Sibley, Rochester; secretary, J. H. Spence. Toronto; manager, T. R. Finucane, Cobalt. The head office of the company is at the Trusts and Guarantee Building, Toronto.

Mining Corporation of Canada.—The Mining Corporation of Canada, Limited, own the Cobalt Townsite, Cobalt Lake, City of Cobalt, Townsite Extension and Little Nipissing mines. The Cobalt Reduction Company is also controlled by the Corporation, which is capitalized at 2,075,000 shares of $1 each, all issued. The officers and directors are: Sir Henry M. Pellatt, president: J. P. Watson, first vice-president: W. R. P. Parker, second vice-president; G. M. Clark, J. G. Watson, D'Arcy Weatherbe, Capt. R. E. G. Van Cutsem; D'Arcy Weatherbe, consulting engineer; C. E. Watson, resident manager; M. F. Fairlie, superintendent of reduction works. The head office is at 1512-1520 Traders' Bank Building, Toronto.

The following statistics of operation are taken from the annual report of the Corporation for 1917:—

Production	Hoisted	Broken	Treated
	tons	tons	tons
Townsite	24,900	10,266	43,074
City	37,527	27,097	37,527
Lake	3,484	1,587	3,484
Total	65,911	38,950	84,085

Of the total tonnage hoisted 416.78 tons of high-grade were treated in the high-grade plant of the Cobalt Reduction Company; 179.07 tons of lower grade shipping ore went direct to the smelter, and 83,488 tons were concentrated. From all sources a total of 4,485,542 ounces of silver was produced, as compared with 4,457,440.80 for 1916. The net profits carried forward amounted to $2,557,091.89. Of this amount, $1,556,296.86 was paid in dividends, and $1,000,795.03 was carried to surplus, which at December 31st, 1917, amounted to $3,448,377.68. High-grade ore treated averaged 3,007.06 ounces per ton, and milling ore averaged 36.99 ounces per ton.

DETAILS OF UNDERGROUND WORK IN 1917

——	Drifts	Cross-cutting	Sinking	Raising	Total	Stoping
	ft.	ft.	ft.	ft.	ft.	cu. ft.
Ore extraction	....	....	....	....	....	468,091
Development	716	....	12	121	849	....
Exploration	785	6,206	327	327	7,645	....
Total	1,501	6,206	339	448	8,494	468,091

Diamond-drilling amounted to 86 feet.

The total footage of drifts, cross-cuts, raises, winzes and shafts in the workings of the Corporation aggregated 21 miles at the end of 1917.

The Cobalt Lake mill was not operated during the year.

The Cobalt Reduction Company's concentrating mill and cyanide plant ran continuously, excepting holidays, during the year. Stamps dropped 95.47 per cent. and the ball mill ran 97.84 per cent. of possible time. The use of the ball mill was discontinued in January, 1917, tube mills were introduced, and the flow sheet somewhat altered during the autumn of 1917.

Extraction from milling ores and slimes was 92.11 per cent. as against 88.34 per cent. in 1916. The high-grade plant has proved an unqualified success. The direct saving over the previous practice of shipping products to the smelter, has more than paid twice the cost of the plant during the year.

The high-grade plant treated during the year 1,546.68 tons of high-grade material, which produced 3,716,611.63 ounces of silver. During 1918, sands from Cobalt Lake will be pumped to stock piles, classified and treated.

The cost of concentrating and cyaniding was $2.53 per ton treated.

CONCENTRATION AND CYANIDING

—	Tons ore concentrated	Tons Concentrates produced	Ounces contained	Tons Slime Cyanided	Ounces Bullion produced by Cyaniding
Townsite and City	80,127.94	1,162.16	2,466,592.21	41,509.31	479,936.34
Lake	3,360.84	58.46	119,301.31	1,730.62	22,643.89
Total	83,488 78	1,220 62	2,585,893.52	43,239 93	502,580 23

The total costs including royalties, head office, etc., per ton of ore treated amounted to $19.26, and 36.11 cents per ounce of silver produced. The average number of men employed was 326.

The total consumption of powder amounted to 180,100 pounds.

Ore reserves at the close of the year were as follows:—

High-grade ore	690,600	ounces.
Milling ore	854,770	"
Total	1,545,370	"

A total of 90 properties in Canada and the United States were examined during the year. In the Cobalt district, the Alexandra and Waldman were optioned in the fall of 1917. Both shafts were de-watered in November, 1917, and development continued until May 1st, 1918, when the Alexandra was abandoned. Work on the Waldman was continued under the direction of Capt. Fancy.

National.—The National Mines, Limited, continued underground development of their mine near Cross Lake, formerly known as the King Edward, up to the end of June, 1917. For the balance of the year, operations were confined to pumping and milling tailings from Cross lake. On December 17th, 1917, the

mill was closed and all operations suspended till April 15th, 1918. On that date milling of King Edward tailings was resumed, and it is the intention of the company to install a second sand-pumping unit, and mill Silver Cliff tailings during the summer of 1918.

The officers are: President, H. E. Jackman; secretary-treasurer, Ernest Whitbeck, both of 17 Ellwood Building, Rochester, N.Y.; manager, C. A. Filteau, Box 749, Cobalt.

Nipissing.—The Nipissing Mining Company (the operating company) has an authorized and issued capital of $250,000, divided into 2,500 shares of par value of $100 each. The officers are: David Fasken, president; E. P. Earle, vice-president; Alexander Fasken, secretary; P. C. Pfeiffer, treasurer. The directors are: W. H. Brouse, David Fasken, E. P. Earle, Richard T. Greene. R. B. Watson is general manager; Charles Butters, consulting metallurgical engineer; Hugh Park, manager; James Johnston, mill manager; James J. Denny, manager research department. Head office, Excelsior Life Building, Toronto.

The stock of the Nipissing Mining Company is held by the Nipissing Mines Company, Limited, of Ontario, which on September 29th, 1917, acquired the assets of the old holding company, known as the Nipissing Mines Company. The officers of the holding company are: E. P. Earle, president; Alexander Fasken, secretary; P. C. Pfeiffer, treasurer; directors, W. H. Brouse, R. T. Greene, E. P. Earle, August Heckscher, David Fasken, J. H. Black, R. B. Watson. Head office, 165 Broadway, New York.

The yearly average price at which silver was sold was 83.19 cents per ounce at Cobalt, which was nearly two cents per ounce higher than the New York yearly average quotation. The total dividends paid to January, 1918, amounted to $16,750,000.

The production of fine silver was 4,212,247.89 ounces having a gross value of $3,756,889.77.

Production costs were $1,057,987.49, equivalent to $14.26 per ton of ore milled, and 25.117 cents per ounce of silver produced, an increase of about one cent per ounce over 1916.

The ore reserves are estimated to contain 8,076,540 ounces of silver as compared with 9,153,139 ounces at the close of 1916.

Underground work done in 1917 is summarized as follows:—

Shaft No.	Drifting	Cross-cutting	Raising	Sinking	Total	Stoping
	ft.	ft.	ft.	ft.	ft.	cu. yds.
14	....	....	....	....	....	208.7
64	....	....	33.0	....	33.0	192.0
73	1,027.0	2,082.5	286.0	89.5	3,485.0	8,471.0
80	6.0	1,118.5	49.5	....	1,174.0	726.8
81	1,827.5	1,278.5	1,102.0	....	4,208.0	15.5
96	221.5	611.5	268.5	....	1,101.5	2,447.6
Total	3,082.0	5,091.0	1,739.0	89.5	10,001.5	12,061.6

Notwithstanding continued heavy increases in the cost of materials and supplies, especially chemicals and articles of iron and steel, the company had one of the most prosperous years in its history. The net value of production was $3,665,405, which was $710,000 more than in 1916, heretofore the highest year for net value received.

Northern Customs Concentrator.—The Northern Customs Concentrators, Limited, situated at mileage 104, T. & N. O. railway, ran continuously in 1917. The ore treated was shipped by La Rose, Right-of-Way, Chambers-Ferland, and a small quantity by Edwards and Wright from the Green-Meehan dump.

The officers are: President, A. J. Young, 702 Excelsior Life Building, Toronto; vice-president, C. J. Booth, Ottawa; general manager and secretary-treasurer, F. J. Bourne, Cobalt; directors, M. J. O'Brien, Renfrew; Dr. C. W. Haentschel, Haileybury.

O'Brien.—Development at the O'Brien mine during 1917 was as follows:—

Drifting and cross-cutting	6,710	feet.
Raising and sinking	410	"
Stoping	42,550	tons.
Hoisted to surface	69,950	"

A new low level was established at 720 feet below the collar of the main shaft and ore mined at this level.

A new shaft, No. 33, was sunk on the southwest quarter of the property, and levels established at 150 and 180 feet. About one-half of the total production came from the Keewatin formation. In the mill, changes were made to effect greater concentration. After concentration the entire tailing product is slimed and cyanided. The mill treated 47,850 tons.

The mine is now owned and operated by M. J. O'Brien, Limited, a new corporation organized during 1917.

The officers are: President, M. J. O'Brien, Renfrew; vice-president, J. A. O'Brien, Renfrew; manager, J. G. Dickenson, Cobalt; mining engineer, Angus Campbell; mine secretary, A. E. McKee.

Ophir.—The Ophir Cobalt Mines, Limited, has a capitalization of 1,500,000 shares of a par value of $1.

The directors of the company are: H. H. Lang, A. D. Crooks, H. H. Hutson, Wm. Linton, W. Murray Alexander, all of the City of Toronto; the head office is 608 Lumsden Building, Toronto.

The Ophir mine operated continuously during the year 1917. The arrangement whereby the underground development is done through the shaft of the People's Mining Company was continued during the year. Most of the underground work was done on the 440-foot level. A winze was started to prospect the downward continuation of a promising ore shoot on this level.

Balmer Neilly of the Penn-Canadian mine is consulting engineer of the company.

Penn-Canadian.—The Penn-Canadian Mines, Limited, operated continuously throughout the year 1917, though on a reduced scale. Very little development

work was done. The mill treated 34,000 tons of ore, produced largely from the old workings. On May 10th, 1918, the power plant was destroyed by fire.

The officers are: President, Wm. J. Haines, Philadelphia; directors, Spencer D. Wright, Philadelphia; Robert B. Haines, Jr., Philadelphia; Jansen D. Haines, Des Moines, Iowa; Elliott C. P. Laidlaw, New York. Balmer Neilly, Cobalt, is manager of the company.

People's.—The working agreement between the People's Silver Mines, Limited, and the Ophir Cobalt Mines, Limited, mentioned in the last annual report of the Bureau of Mines, was continued throughout 1917. Development of the Ophir ground has proved satisfactory and some promising veins have been encountered.

Cross-cutting and drifting were done by contract, let to Messrs. Cain and Smith, under the direction of mine captain Donaldson.

Balmer Neilly, manager of the Penn-Canadian is consulting engineer for the company.

The officers of the People's company are: President, G. P. Bithell, 773 St. Lawrence Boulevard, Montreal; vice-president, James Robertson, Millerton, N.B.; secretary-treasurer, T. Jones, 773 St. Lawrence Boulevard, Montreal.

Ten men were employed by the contractors.

Peterson Lake.—The Peterson Lake Silver Cobalt Mining Company, Limited, worked continuously during 1917. The cross-cut to the northwest at the 200-foot level of the Susquehanna shaft was extended, and in July a vein was encountered. Further developments were not encouraging, and work was suspended. The force was moved to the Cart Lake section at the Gould No. 2 shaft, where work was continued. Total development at the Susquehanna and Gould shafts in drifting, cross-cutting, sinking and raising for the nine months ending January 31st, 1918, amounted to 1,050 feet.

The officers are: President, W. A. Lamport; vice-president and managing director, S. G. Forst; secretary-treasurer, P. M. Goff, all of Toronto; directors, W. A. Lamport, S. G. Forst, Chas. M. Nickel, Max B. Borg, New York; Irving L. Ernst, New York. Head office, 909 Excelsior Life Building, Toronto.

Prince-Davis.—Operations through the Lumsden shaft by the Prince-Davis Mining Company, Limited, on the Prince lot in southeast Coleman, were discontinued in April, 1918. A cross-cut was run over 850 feet on the Prince ground, but developments were not encouraging.

Underground work was in charge of Captain Donaldson. Balmer Neilly, manager of the Penn-Canadian is consulting engineer for the company.

Eight men were employed by contractors Gordon and Robert Cameron.

Provincial.—Under the direction of John Redington, the mill of the Cobalt Provincial mine was enlarged, and during the winter of 1917-18, 1,000 tons of tailings were treated. No. 2 shaft was de-watered to the 175-foot level and work resumed in the cross-cut to No. 1 shaft. There is considerable ground on the south side of the property, as yet not prospected, and it is the intention of the management to carry on active underground development during the coming year.

Right-of-Way.—The Right-of-Way Mines, Limited, did a small amount of development work during 1917. Operations were confined to No. 2 shaft at the north end of Cobalt lake. Development during the year at No. 2 shaft was as follows:—

Sinking	82	feet.
Raising	110	"
Drifting	352	"
Cróss-cutting	88	"
Total	632	"

Work on the 465-foot level to the close of the year had not proved satisfactory, but development was still in progress. The net value of ore produced during 1917 amounted to $45,506.61.

The officers are: President, E. Seybold; secretary-treasurer, E. A. Larmonth; director, C. Jackson Booth, all of Ottawa. A. W. Fraser, K.C., of Ottawa, who had been a director and vice-president of the company since its incorporation, died on August 11th, 1917. D. H. Angus, Cobalt, is superintendent, and the head office of the company is at Central Chambers, 46 Elgin Street, Ottawa.

Shamrock.—The Shamrock Consolidated Mines, Limited, worked with a small force for the greater part of the year, and closed in November, 1917. Development consisted of drifting on the 200 and 300-foot levels, and a small amount of stoping on the latter.

H. S. Anderson, 93 Queen St. East, Toronto, is secretary of the company, and J. P. Cleveland was in charge of operations at the property.

Silver Queen.—In June, 1917, the Silver Queen mine was leased to Geo. A. Irwin, of Cobalt, who worked it with a small force of men during the balance of the year. A car of ore was shipped in September, and a second car in March, 1918. The ore was obtained mostly from the old dumps and from wall-slashing on the first level. There is considerable milling ore in sight, and if proper milling arrangements can be made, the output for 1918 should be considerably increased.

Temiskaming.—The following information is taken from the eleventh annual report of the Temiskaming Mining Company, Limited, for the fiscal year ending December 31st, 1917. This report was issued by the old board of directors, as given in the last annual report of the Bureau of Mines. During the year 1917 Frank L. Culver was president and general manager of the company. Head office is at Lumsden Building, Toronto.

The main shaft was sunk to the 1,600-foot level, through the diabase sill, and considerable development work at that level failed to disclose commercial ore. Development is being continued.

Production during the year amounted to 958,669.88 ounces of silver. The cost of production was 31.56 cents per ounce.

Following is a summary of development:—

Drifting	1,371.0	feet.
Cross-cutting	2,677.5	"
Sinking	117.1	"
Raising	701.5	"
Winzing	28.4	"
Total	4,895.5	"
Stoping	4,455.5	cubic yards.

Four dividends of $75,000 each were paid during the year.

Three Stars.—The Three Stars Silver Mines, Limited, was organized early in 1918 and resumed work March 1st, 1918, on the Cyril lake or Airgoid property, worked during 1916 by the Calumet and Montana Consolidated Mining Company, Limited. The capitalization of the new company is $3,000,000, divided into 600,000 shares par value $5 each.

Operations were suspended in May, 1917, by the Calumet company.

The north cross-cut on the 90-foot level is being extended, and drifting is in progress on a promising vein running directly east from the cross-cut.

The officers are: President, Henry A. Oswald, Cobalt; vice-president, K. J. Schumacher, Chicago; secretary-treasurer, H. R. Mendis, Chicago. The board of directors includes the above officers, R. G. Collins, and Chauncey W. Martyn, of Chicago.

Trethewey.—The mine and mill of the Trethewey Silver Cobalt Mining Company, Limited, operated throughout the year. Very little new ground remained for exploration, and as a result development was discontinued in June, 1917, and work confined to the old stopes. Drifting and cross-cutting amounted to 463 feet, raising and winzing to 12 feet. The net decrease in tonnage of ore reserves at the close of 1917 amounted to 13 per cent., while the estimated ounces of silver in the ore reserves decreased from 361,482 to 264,044 ounces, a net decrease of 27 per cent. A total of 23,013 tons of ore was broken in the stopes, at a cost of $2.60 per ton. Most of this production came fom the walls of old stopes. The mill treated 34,722 tons of ore, having an average content of 13.3 ounces, at a cost of $1.744 per ton treated, including all charges from the shaft-house bins. From this ore, 341,278.23 ounces of silver were obtained. The average assay of the tailings was 3.2 ounces, giving an extraction of 75.2 per cent. High-grade concentrates were shipped to Deloro and Thorold, and low-grade ones to Denver. The net value of ore produced was $259,208.60, leaving a profit of $114,977.33. The total cost per ton produced, including marketing charges, was $4.827.

Rochester Mine.—Operations were discontinued at the Rochester, March 1st, 1917. The third level was considered fully explored, and it was decided to make no further expenditures. The total expenditures on the Rochester during the year amounted to $14,549.17.

Cane Silver Mine.—The Trethewey company secured an option on three claims known as the Caroux claims in Cane township, in June, 1917, and carried on operations for a period of six weeks. Considerable stripping was done and a

shaft sunk to a depth of 40 feet. There were several strong fractures on the surface showing good values, but operations were closed in August.

The officers are: President, S. R. Wickett, Toronto; vice-president, J. B. Tudhope, Orillia; secretary-treasurer, L. J. Pashler, Toronto; directors, Gordon Taylor, Toronto; J. P. Bickell, Toronto; W. J. Sheppard, Waubashene; T. E. Leather, Hamilton. The head office is at 1428 Traders' Bank Building, Toronto.

I. S. McReavy, Cobalt, is manager, succeeding H. S. Robinson, who returned to the United States in August, to join the overseas forces.

Gowganda and Elk Lake Silver Mines

During 1917 the Gowganda area received considerable attention from mining companies in search of new properties. This interest was no doubt due to the discovery in 1916 of high-grade ore on the O'Brien property at Miller lake, and the increased selling price of silver. A large number of claims have been patented and held since 1910 by the older operating companies of Cobalt and Porcupine, and it is probable that some of these claims may become producing mines through systematic prospecting and development.

In the Elk Lake section some work was also done.

Bishop.—The Bishop Silver Mines, Limited, operated only part of the year on their claim L.O. 313, situated on the east side of Calcite lake, township of Lawson. The winze near the end of the main drift was sunk to the 100-foot level, and a small amount of cross-cutting done. Previous development is described in the Twenty-sixth Report of the Bureau of Mines. The mine was closed on April 30th, 1917, and no further work was done during the year.

Wm. J. Shields was manager of the mine.

Castle.—At the beginning of the year the Trethewey Silver Cobalt Mining Company, Limited, secured an option on the control of the stock of the Castle Mining Company, Limited. The holdings comprise eleven claims near Miller lake, in the Gowganda district. Eight of these claims lie along contacts very favourable for ore deposition.

Prospecting and surface development were carried on during the summer and fall of 1917, and during the winter a plant was taken in and installed. The plant includes two 60-h.p. boilers; one 8 by 10 Jenckes hoist; one Rand compressor, 720 cubic feet capacity. Sinking operations were started in May, 1918.

R. E. Margenau was superintendent for the Trethewey Company.

Crews-McFarlan.—Early in the year the Crews-McFarlan Mining Company, Limited, purchased the Bartlett property in the township of Milner, in all about 132 acres. On this property were two vertical shafts, No. 1, 110 feet deep, and No. 2, 110 feet. Most of the force from the Hewitt Lake workings were transferred to the Bartlett, and active development commenced July 15th, 1917, Both shafts were de-watered and re-timbered and sinking was resumed.

At the Hewitt Lake property shaft No. 1 was sunk to a depth of 150 feet, and work on this claim was stopped. On claim J.S. 280, No. 2 shaft was 140 feet deep with sinking in progress, when last inspected in October, 1917.

The officers are: President, C. H. Streit, Nutley, N.J.; secretary, Henry Crews, Paterson, N.J.; treasurer, W. J. McFarlan, Paterson, N.J.; manager, J. G. Wheaton, Gowganda P.O.; 25 men were employed during the year.

Kenabeek.—During 1917, the Kenabeek Consolidated Silver Mines, Limited, worked intermittently, and did a small amount of development on their property, south half of lot 2, in the sixth concession of Auld township. The shaft was sunk to the 150-foot level, and 82 feet of cross-cutting and drifting done, chiefly on No. 2 vein. A small prospect winze was sunk on the intermediate vein.

The head office of the company is at 232 St. James Street, Montreal, and the officers are: President, Frank Thompson; director, E. Champagne; manager, Capt. W. H. Jeffrey. George Pyke, formerly secretary-treasurer, died during the year.

Miller-Lake O'Brien.—Production at this mine during 1917 placed it among the first half-dozen silver producers of Canada.

Development during the year was as follows:—

Drifting and cross-cutting	1,907 lineal feet.
Raising and sinking	90 " "
Stoping	12,324 tons.
Hoisted to surface	18,200 "

A fine new office building, with sleeping quarters for the staff, was built during the year.

The mine is owned and operated by M. J. O'Brien, Limited, with the same officers as given for the O'Brien mine at Cobalt, with the addition of B. C. Crowe as resident superintendent.

Reeve-Dobie.—The Reeve-Dobie Mines, Limited, resumed operations in April, 1917, and worked with a small force for the balance of the year. A shipment of high-grade ore was taken from an open-cut about 450 feet from the main shaft. During the summer the mill was repaired, and in September the main shaft was de-watered. The mill equipment includes four Nissen stamps, four Deister tables, one Risdon-Johnston concentrator, and one jaw crusher.

Mr. A. S. Crowe, formerly of the Porcupine Crown staff, took over the management on November 1st. During the winter one machine crew was employed cross-cutting on the 100-foot level.

The officers are: President, Charles Ward, Livonia, N.Y.; vice-president, H. Marvin, Rochester, N.Y.; secretary, J. C. Roche, Rochester, N.Y.; treasurer, Dr. J. H. Fennessey, Rochester, N.Y.

The property comprises claims S.W. 3, 4, and 5, on the Mann ridge, west of Gowganda lake. S. Christopherson was in charge of operations until November 1st.

T.C. 177.—The T.C. 177 Mining Company, Limited, worked continuously on their claims south of the Miller-Lake O'Brien property.

Camps were erected in February, 1917, and when visited on September 27th, 1917, a vertical shaft had been sunk to a depth of 77 feet, with sinking in progress. In May, 1918, the shaft had reached the 200-foot level and cross-cutting had been started. The plant includes one 40-h.p. locomotive boiler, one 4 by 5 hoist, and a small compressor.

Miles Simpson, Elk Lake, was manager, and Joseph Brevier, mine captain.

Walsh.—What were known locally as the Walsh claims, in the Miller Lake section of the Gowganda district, were optioned during the year to the Crown Reserve Mining Company of Cobalt. A small plant was installed, a shaft sunk 100 feet, and a small amount of lateral development performed during the year. Work was under the direction of H. J. Stewart, manager of the Crown Reserve.

Lorrain and South Lorrain

During 1917 the chief operating company was the Pittsburg-Lorrain Syndicate, working on the Currie mine. The Bellellen was closed for several months of the year. From March 20th to July 15th there was no development work carried on, although the pumps were kept running. The Lorrain Consolidated, formerly known as the Harris property, closed down on June 15th, 1917. The Pittsburg Lorrain shipped considerable high-grade ore, and late in the year took over the Wettlaufer mill and mine under lease.

In the spring of 1918 the Keeley mine, formerly one of the chief producers, was examined, and a shipment made of ore in stock from previous operations. It is probable that this mine will be worked during 1918.

Bellellen.—The syndicate operating the Bellellen, on claim R.L. 470, South Lorrain, continued development from the first of the year to March 20th, 1917, when all operations except pumping were suspended. On July 15th work was resumed until the close of the year.

The winze on the 100-foot level was sunk to a depth of 275 feet, and at the 200-foot winze level a drift was run to the south, a distance of 100 feet.

The members of the operating syndicate are as follows: Charles Richardson, Haileybury, manager; Arthur Ferland and R. T. Shillington, of Haileybury, and J. H. Black, Toronto.

Sylvester Carroll was in charge of operations, employing ten men.

Curry.—Development of the Curry mine, in South Lorrain, was continued during 1917 by the Pittsburgh-Lorrain Syndicate. Some high-grade ore was stoped on the fourth level. In August, 1917, the syndicate acquired the Wettlaufer mine and mill under lease. Operations at the Curry mine were suspended, and during the autumn of 1917 the Wettlaufer dump was milled. At the Wettlaufer about 750 feet of drifting and cross-cutting were done on the third and fourth levels, but no new veins were discovered. Underground work at the Curry mine was resumed and the mill has since been treating Curry ore.

The mill has been enlarged and the grinding capacity increased by the addition of one 5 ft. by 3 ft. ball mill. An experimental Groch flotation unit was installed. Exploration by diamond-drilling was carried on extensively at the Curry mine during the year.

H. F. Strong is superintendent, employing 40 men; John A. Rice is consulting engineer. Thomas B. Rice, who had been superintendent for the past three years, left in September, 1917, to join the American overseas forces training in Texas.

Maple Mountain Area

White Reserve.—Work was continued throughout the year by the White Reserve Mining Company, Limited, on its claims in the Maple Mountain area, Timagami Forest Reserve.

The main shaft is 147 feet deep, with levels at 70 and 140 feet. Development on the 70-foot level consists of 215 feet of cross-cutting and drifting, and on the 140-foot level north of the shaft, 492 feet of cross-cutting and drifting; south of shaft, 330 feet of cross-cutting and drifting. No. 21 shaft is 90 feet deep, with 110 feet of drifting at the 30-foot level. No. 10 shaft is 50 feet deep, and No. 14 shaft, 30 feet deep.

J. A. McAndrew, 408 Lumsden Building, Toronto, is president and general manager of the company.

IV.—EASTERN ONTARIO

Iron Pyrites

Bannockburn.—The Bannockburn Pyrite Mining Company has opened up what is known locally as the "Mundic" mine, on lot 25, con. VI., Madoc township. The open pit on this property is about 50 feet wide by 100 feet in length and 60 feet in depth. The equipment includes two small boilers and a hoist. J. A. Anderson, Bannockburn, is manager.

Caldwell.—Development was continued during the year on the pyrite property owned by T. B. Caldwell, of Lanark, on lots 1 and 2, in the first concession of Blithefield township. The shaft was continued to the 100-foot level, and 250 feet of cross-cutting and drifting done at this level. In October, 1917, the property was optioned to the Grasselli Chemical Company. During the winter and spring of 1917-1918 about 2,500 feet of exploration by diamond-drilling was done by the Sullivan company. In June, 1918, a wagon road was being built from Clyde Lake siding to the mine, and preparations were under way for extensive development by the new owners.

D. S. Tovey is superintendent for the Grasselli Chemical Company.

Sulphide.—The Nichols Chemical Company, a subsidiary of the General Chemical Company of New York, operated its pyrites mine and chemical plant at Sulphide, Hastings county, to full capacity during the year. The mine and plant are located on lot 23, in the eleventh concession of the township of Hungerford. The same company operates pyrites mines at Northpines and Goudreau, in the Lake Superior region of Ontario.

The enlargement of the chemical plant continued during 1917, the increased demand for acid being met by the installation of additional pyrites burners. The consumption of crude sulphur also increased during the year.

At the mine there was no addition to the equipment. The ore was extracted from the first, second, third, and fourth levels.

During the year a recreation hall, including bowling alleys, billiard tables and moving picture fixtures, was built at the plant for the company's employees. This

recreation club is operated by a committee of the employees, which pays the company interest on the capital expenditure and is in full control of the operation of the club.

W. H. DeBlois is manager, employing 150 men at the chemical plant and 35 men at the mine.

Queensboro Mine.—This mine, near Queensboro, in the township of Madoc, is owned and operated by the Canadian Sulphur Ore Company.

Sinking was continued to the 400-foot level and will be continued to the 500-foot level during the year 1918. The fourth level was extended east and west to the extent of the ore bodies in No. 3 shaft.

Good-sized ore bodies have been blocked out in No. 2 shaft, and No. 3 workings connected with No. 2 by means of a winze from No. 2 and a raise to connect from No. 3.

The officers of the company are: Alex. Longwell, Toronto, president; Geo. H. Gillespie, Madoc, vice-president; H. F. Smeaton, Queensboro, superintendent. Eighty men were employed during the year.

Copper

Cashel Copper Mines, Limited.—This company, operating on the east half and the south 20 acres of the west half of lot 31, in the first concession of Cashel township, near Gilmour, Hastings county, continued sinking a shaft to a depth of 80 feet, when work was discontinued.

C. S. Crysler is president and manager; W. Younger, vice-president; E. W. Storer, treasurer; S. B. Dawson, secretary.

Gold

Cordova Mines, Limited.—The Cordova mine is situated in Belmont township, Peterborough county, 12 miles by wagon road northeast of Havelock, and 112 miles east of the city of Toronto. After the disastrous fire on March 13th, 1917, which destroyed the shaft-house, mill, etc., rebuilding operations were commenced, but, owing to labour conditions and the difficulty of procuring supplies, it was not considered advisable to attempt to replace the plant at the present time.

Peter Kirkegaard is managing director; the head office is at Cordova Mines, Ont.

Cobalt-Frontenac Mining Company, Limited.—Mining rights owned by this company in Eastern Ontario include the following properties:—Lots 24 and 25, concession VI., township of Kaladar, known and described in previous reports as the Golden Fleece mine; north half of lot 26, and the southwest quarter of lot 27, concession VII., township of Kaladar, and lot 33, concession 1, township of Barrie, a total of about 700 acres.

On the Scootamatta river, near the village of Flinton, the company has completed the construction of a hydro-electric power plant, which has been developed as a source of electrical energy for the Golden Fleece mine. The erection of a 200-ton ore bin has just been completed, on the top of which has been installed a

14 by 24 Mitchell crusher with a capacity of 300 tons in ten hours. The ore will pass through the crusher into the ore bin, thence by means of an automatic feeder will be fed through a small Dodge crusher into a 60-ton ore bin. A stamp mill and a 5 by 16 tube mill in closed circuit with a Dorr classifier will be used for the further reduction of the ore. A Dorr continuous decantation cyanide plant with a capacity of 200 tons per twenty-four hours has been ordered, shipment of which will be made about the first of June. A two-stage, belt-driven Ingersoll Rand air compressor has been purchased and is being installed. Two 100-h.p. electric motors (power for which will be furnished by company's own hydro-electric power plant) have been installed for the operation of the mine and mill. The ore will be treated by amalgamation until such time as the cyanide plant is completed.

On the 1st of May, 1918, the company's head office was moved from Hamilton to the Golden Fleece mine, Flinton, Ontario.

The officers of the company are: George W. Millen, president, Winona, Ontario; M. G. Notz, secretary-treasurer, Hamilton, Ontario; D. H. Fletcher, managing director, Hamilton, Ontario; W. E. Simpson, consulting engineer, Flinton, Ontario.

Ore Chimney.—This mine, situated near Northbrook, in the township of Barrie, Frontenac county, is operated by the Ore Chimney Mining Company.

Up to January 1st, 1918, there had been 2,000 feet of cross-cutting and drifting done on the six several levels. The raise to the second or auxiliary shaft is almost completed.

At the mill, since the last Report, which gave a list of the machinery installed, there has been added one No. 2 Ding magnetic separator and a 200-h.p. generator.

The officers of the company are: A. E. Fletcher, president, and O. E. Dores, secretary-treasurer.

Iron

Playfair.—The Playfair hematite mine, which had been abandoned for upwards of forty years, was re-opened in the autumn of 1917 by the Canadian Union Iron Mines Company. Head office, Dominion Express Building, St. James Street, Montreal. H. L. Coombs, president.

A contract was let to L. Lemoine, of 524 Lafontaine Park, Montreal, to de-water the shaft, and mine 1,000 tons of ore. The property is located near Playfairville, in the township of Bathurst, Lanark county. When inspected on June 11th, 1918, the shaft, said to be 110 feet deep, was de-watered to a depth of 75 feet, and ore was being shipped from Perth, a wagon haul of twelve miles.

The vein where exposed varies from 2 to 4 feet in width, and Mr. Lemoine stated that the ore was of excellent quality for blast-furnace use.

Talc

Connolly Mine.—The Anglo-American Talc Corporation, Limited, owns and operates what is known as the Connolly mine on the northwest quarter of lot 15 in the fourteenth concession of the township of Huntingdon, adjoining the village of Madoc in Hastings county.

H. S. Predmore is president of the company; R. J. Gilchrist, secretary; Thos. Carswell, resident manager; on an average 20 men were employed during the year.

The underground work during the year consisted in sinking the shaft to a depth of 188 feet, and drifting on this level east 275 feet and west 100 feet. On the 127-foot level the east drift was continued to a point 288 feet and the west drift to a point 100 feet from the shaft.

The mill commenced grinding in May, 1917, and was run continuously throughout the remainder of the year. Some crude talc was shipped in addition to the mill product. The mill has a daily capacity of 25 tons.

Geo. H. Gillespie and Co.—This company operates a talc-grinding plant at Madoc station on the Grand Trunk railway, the talc being all obtained from the Henderson mine operated by Cross and Wellington.

The plant ran continuously throughout the year, although part of the time at only about two-thirds the capacity, due to shortage of railway cars in which to ship the refined product.

Eighteen men were employed in the mill during the year; Geo. H. Gillespie is general manager.

Henderson Mine.—Messrs. Cross and Wellington, who have this mine under lease, operated continuously during the year. The mine is situated near Madoc in Hastings county. The greater part of the production is supplied to George H. Gillespie and Company, Limited, at Madoc, though some crude ore is shipped.

The production, which amounted to about 11,000 tons, came entirely from the sub-levels between the second and third levels, where the top-slicing and retreating method of mining is followed.

No. 2, or the east shaft, was sunk to the third level at a depth of 231 feet, and a connection made on this level with No. 1 shaft. A plant was installed at the shaft consisting of a 235-cu. ft. compressor, a 40-h.p. motor and an 8 by 10 hoist. The ore will be hoisted in a 24-cu. ft. skip.

Fourteen men were employed on an average during the year. Stephen Wellington is manager.

International Pulp Company.—On lot 16 in the fourteenth concession of Huntingdon township the International Pulp Company of Gouverneur, N.Y., is prospecting for talc. An incline shaft has been sunk to a depth of 50 feet, and it is the intention to cross-cut from this level.

A small plant, including compressor, hoist and boiler, has been installed. D. Brownson is manager, employing eight men.

Fluorspar

Fluorspar was found in 1918 on the Schickler farm on lot 8, concession XXII, Cardiff township, near the village of Harcourt on the Canadian Northern railway in Haliburton county. The vein is of good width, the fluorspar, which is of the violet-blue variety, being associated with calcite. Crystals of apatite were also noticed in the vein material.

P. J. Dwyer, of Wilberforce, has the property under option.

Bailey.—The Bailey property is situated on lot I in the fourth concession of Madoc township. The shaft is 40 feet deep, and 35 feet of drifting has been done at the 40-foot level.

This deposit was opened up late in 1916 by the Hungerford Syndicate (Harry Hungerford and Robert Gilchrist). Robert Phillips was in charge of operations.

The vein matter is well crystallized, and some first-rate spar was taken out during development.

Canadian Fluorite, Limited.—This company, through J. W. Bradley, is operating the Kane property, lot 9 in the fourteenth concession of Huntingdon township, from which shipments are being made to the new steel plants of British Forgings, Limited, at Toronto. The shaft is 25 feet deep on a vein about 9 feet wide. The vein matter is largely calcite. At the 25-foot depth there is considerable fluorite in the vein.

The plant consists of a 325-cu. ft. compressor, 35-h.p. upright boiler, and an 8 by 12 hoist.

E. D. Hall is superintendent, employing 10 men.

Noyes.—Canadian Industrial Minerals, Limited, is the name of the company operating the property formerly known as the Noyes and owned by Wellington and Munro. The company has a capitalization of 500,000 shares of a par value of $1.00. The officials of the company are: J. P. Watson, president; W. R. P. Parker, vice-president; G. M. Clark; and W. W. Perry, secretary-treasurer. The head office of the company is at 1512-1520 Bank of Hamilton, Toronto.

The company owns the following parcels totalling about 800 acres: lot 13, con. XII; lot 14, con. XI; lot 15, con. X; lot 16, con. IX, and the N. ½ of W. ½ of lot 12, con. XI, all in the township of Huntingdon.

The present workings are confined to part of lot 13, con. XII. An incline shaft has been sunk to a depth of 100 feet on a vein of fluorspar which averages from 8 to 12 feet in width at this point. On the 50-foot level drifts were run 85 feet to the south and 55 feet to the north.

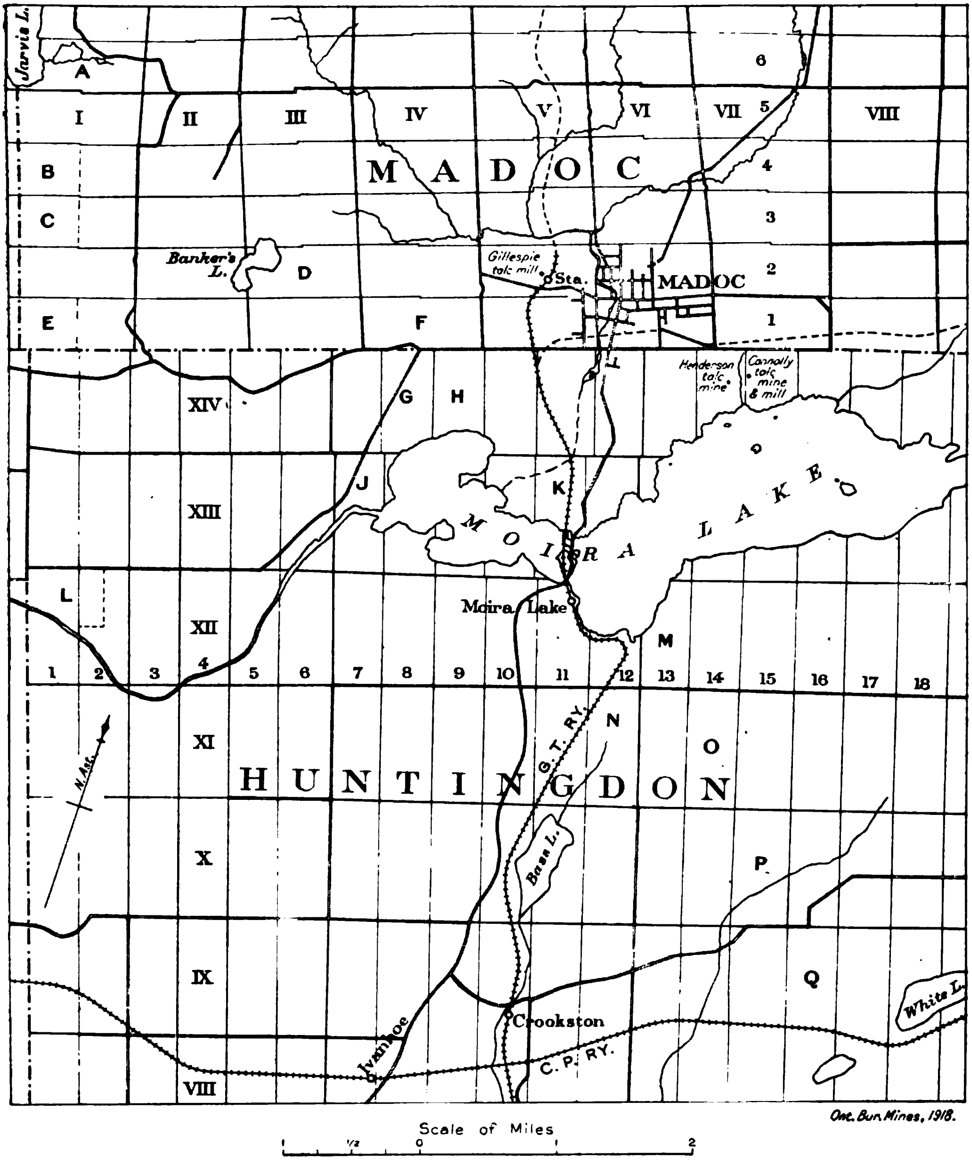
The present equipment includes a small boiler and a hoist and small compressor. A 784-cu. ft. compressor, electrically driven by a 125-h.p. motor, is being installed. The company has a railway siding at Moira Lake station about half a mile from the property. A. W. Grierson is resident manager, employing 18 men.

Cross and Wellington.—From the Perry property, on lot 11 in the thirteenth concession of Huntingdon township, about 2,000 tons of ore were shipped during the year.

No. 1 shaft, on the shore of Hog lake, is 35 feet deep. No. 2 shaft is 1,050 feet north of No. 1 shaft. No. 3 shaft, 175 feet north of No. 2, was sunk to a depth of 95 feet during the year. This property was shut down on December 1st, it being decided not to attempt any further mining until an adequate pumping plant was installed.

The power house contains a 470-cu. ft. compressor, a 75-h.p. motor and an 8 by 10 hoist.

Stephen Wellington is manager, employing 10 men.



Map of parts of the townships of Madoc and Huntingdon, showing location of fluorite properties near Madoc, Ont.

Madoc Tp.

A.—Lot 6, Con. 1—O'Reilly.
B.—Lot 4, Con. 1—Wallbridge.
C.—Lot 3, Con. 1—Ponton.
D.—Lot 2, Con. 3—McIlroy.
E.—Lot 1, Con. 1—Lee.
F.—Lot 1, Con. 4—Bailey.

Huntingdon Tp.

G.—Lot 8, Con. 14—North Reynolds.
H.—Lot 9, Con. 14—Canadian Fluorite, Ltd.
J.—Lot 7, Con. 13—South Reynolds.
K.—Lot 11, Con. 13—Perry.
L.—Lot 1-2, Con. 12—Herrington.
M.—Lot 13, Con. 12—Canadian Industrial Minerals, Ltd.
N.—Lot 12, Con. 11—Canadian Industrial Minerals, Ltd.
O.—Lot 14, Con. 11—Canadian Industrial Minerals, Ltd.
P.—Lot 15, Con. 10—Canadian Industrial Minerals, Ltd.
Q.—Lot 16, Con. 9—Canadian Industrial Minerals, Ltd.

Herrington.—The Herrington property, lots 1 and 2 in the twelfth concession of Huntingdon township, has been leased by Chas. Henrotin. Thirteen tons have been shipped. The vein, which is about 18 inches in width, has been stripped for 250 feet.

Lee.—The Lee property, which is situated on the west half of lot 1 in the first concession of Madoc township, is held under lease by Chas. Henrotin. Five cars have been shipped from an open cut. The vein is 3 feet wide at its widest part. The open cut is 500 feet long and is in places 8 feet deep.

McIlroy.—This property, situated on lot 2 in the fourth concession of Madoc township, is operated by Mineral Products, Limited. The vein, which is one to three feet wide, is developed by a shaft and an open pit.

Perry.—From the Perry property, lot 2, concession XIII, Huntingdon township, operated by Cross and Wellington, about 3,000 tons of fluorspar has been shipped. The property is shut down at present owing to water trouble. It is the intention of its operators to install a double-action, motor-driven Cornish pump to overcome the difficulty.

There are three shafts which are respectively 35, 80 and 95 feet deep.

The plant consists of a 50-h.p. boiler, a 470-cu. ft. compressor driven by a 75-h.p. motor, and an 8 by 12 hoist.

Reynolds.—The South Reynolds property, situated on lot 7, concession XIII, Huntingdon township, is under option to Chas. Henrotin. Two carloads of fluorite have been shipped from an open cut on the vein; this vein is narrow, being under 18 inches wide. About 150 feet has been exposed in the open cut.

Wallbridge.—The Wallbridge property, situated on the west half of lot 1 in the fourth concession of Madoc township, has produced 380 tons of spar. The vein has been stripped 500 feet. It varies from one to three feet wide. A second vein, 700 feet west of the first, has been uncovered for 100 feet. In a pit 15 feet deep on this second vein at the boundary with the Ponton property, the vein is six inches wide.

On the Ponton property, the west half of lot 3 in the first concession of Madoc township, a vein stripped for 300 feet is up to 3 feet wide.

Lead

Galetta.—The Galetta lead mine and smelter, belonging to the Estate of James Robertson, are situated on Chats island, on lot 22 in the sixth concession of the township of Fitzroy.

The mine developed favourably during the year. On the second, or 185-foot level, the vein was drifted on to the east 394 feet and to the west 66 feet.

No. 2 shaft, which is a vertical, 3-compartment one, located 60 feet south of No. 1 and in the hanging-wall side of the vein, was sunk to a depth of 225 feet. From the bottom a drift was driven to the east 100 feet and stoping commenced. The mill was brought up to a capacity of 50 tons per day.

The smelter, which has a capacity of 18 tons of pig lead every 24 hours, operated about 50 per cent. of the time. The open Scotch hearth with automatic rabble is used. The grey slag from the hearth is stock-piled for future treatment in blast furnace.

During the year 18 dwelling houses were built for the employees. A. G. Munich is general manager, and C. M. Thompson mine superintendent; employing on an average 65 men.

Feldspar

Card.—The Card feldspar and flint quarry near Verona, owned by Senator Richardson, of Kingston, was opened in October, 1917. About 20 cars of feldspar and flint rock were shipped and the quarry closed in May, 1918.

Sam Hunter was in charge of operations, employing six men.

Feldspars, Limited.—Work was continued throughout the year 1917 in the Desert Lake quarry operated by this company near Verona in Frontenac county. The proposed changes in methods of transportation to track, mentioned in the Twenty-sixth Report, were not made during the year, and when inspected in June, 1918, the ore was being transported to Glendower siding in scows as before

Hoisting by derricks in open buckets has been abandoned, and all ore is lifted to the rock house in skips on the incline track, the loading pocket being located in a central position in the pit.

The entire spar production is now being utilized by the United States military authorities in the manufacture of insulating material. The ore was formerly transhipped from cars to boats at Kingston, but now crosses the lake on the Grand Trunk ferry operating between Cobourg and Genesee dock, where the grinding plant is located.

The officers of the company are: S. Harry Worth, president; Fred Zoller, Rochester, vice-president; R. F. Segsworth, Toronto, secretary-treasurer; the head office is at 103 Bay St., Toronto. Ralph Scott is superintendent, and George Gray assistant superintendent. An average force of 75 men was employed during 1917.

Feldspar Milling Company, Limited.—The feldspar grinding plant near Parham station, Canadian Pacific railway, is operated by this company, which was organized in 1917. During the year the plant was remodelled and grinding stones and a pebble mill added. The product is ground to 200-mesh and shipped to the trade in bags.

A. W. Adams was superintendent in 1917, and since March 1st, 1918, Geo. W. Hurlburt has been in charge.

The officers are: F. H. Hurlburt, president; Geo. W. Hurlburt, manager; Dr. Morrison, secretary-treasurer; head office, 33 Richmond Street West, Toronto.

Feldspar Quarries, Limited.—The quarry owned by this company, situated on the west half of lot 16 in the tenth concession of the township of Portland, was operated continuously during 1917. The product is teamed to Verona on the Canadian Pacific railway. The manager reports shipments of 6,000 tons of high-grade spar during the year 1917.

The pit when last inspected, on June 4th, 1918, was 150 feet long and 80 feet deep. A considerable body of spar was exposed, but a large tonnage of capping on the hanging-wall side required to be removed to permit of its recovery.

The head office of the company is at 33 Richmond Street, Toronto. George W. Hurlburt is manager, employing 15 men.

Eureka Flint and Spar Company.—This is an American corporation with head office and works at Trenton, N.J. For some years it has been one of the largest producers and purchasers of spar and flint rock in the United States and Canada.

Operations were commenced in October, 1917, on the Emery farm near Verona, on part of lot 16 in the tenth concession of the township of Portland. On June 4th, 1918, the open pit measured 125 feet long by 35 feet wide and 30 feet deep. The quarry adjoins the Hurlburt property. The plant consists of one upright boiler, 22-h.p., one Beatty hoist and one stiff-leg derrick.

Shipments are made from this quarry to the company's plant at Trenton, N.J., and the Canadian representative, John C. Wilkes, also purchases spar and flint for use in the pottery trade.

The officers of the company are: John E. Throp, president; Thos. H. Throp, vice-president; Frank W. Throp, treasurer; Peter D. Throp, secretary. Operations in Canada are in charge of John C. Wilkes, Verona.

National Potash.—The National Potash Corporation, Limited, has an authorized capitalization of 1,500,000 shares of a par value of $1.00. The directors are: E. L. Wettlaufer, Toronto, president; William Calder, Durham, general manager; D. J. Benham, Toronto, secretary; W. S. Milne, Toronto, treasurer; H. T. Whaley, Toronto. The head office of the company is at 178 Spadina Avenue, Toronto. The works and quarry are at Gravenhurst (Muskoka Wharf). S. J. McCarthy is works manager, employing 45 men.

The quarry is at present being operated for crushed rock for road material. The face of the quarry is about 60 feet in height. The work is done under contract and about 200 tons of rock are crushed daily. As shipped, the product runs from ⅜-inch to 2½-inch. The feldspar is being stockpiled until the smelting plant is completed.

The plant being installed comprises a blast furnace 192 in. by 42 in. with a capacity of 200 tons a day; one 175-h.p. engine; two 600-cu. ft. blowers, two 25,000 induction fans; two 325-h.p. B. and W. boilers; one 300-cu. ft. compressor, and one set of evaporators. It is electrically operated.

Orser and Kraft.—The feldspar quarry on lots 12 and 13 in the fifth concession of the township of South Sherbrooke, was worked at intervals during 1917. A siding was built at Mud Lake station on the Canadian Pacific railway, one and one-half miles from the quarry, and in the spring of 1918 regular shipments amounting to 100 tons per week were going forward.

In this quarry the radium-bearing mineral euxenite was found which is described by Dr. W. G. Miller and C. W. Knight in the Twenty-sixth Report of the Bureau of Mines.

Mica

Lacey.—The Lacey mine, near the village of Sydenham in Loughborough township, worked continuously during 1917. From July to December operations were carried on in the open pit, which is now 200 feet deep. During the winter months work was continued in the "milky vein" stope, a parallel ore body connected with the main shaft by a cross-cut about 60 feet to the southwest. This stope averages 16 feet wide and 200 feet long, and from the floor to the back in the deepest part of the stope is 80 feet. The ore is hand-cobbed underground and roughly trimmed in the shop at the shaft collar, before shipment to the company works at Sorel, Quebec, where it is finished for the market.

Henry Smith, for many years superintendent of this mine, died December 14th, 1917, and was succeeded by his brother, Richard Smith. The mine is owned and operated by the Loughborough Mining Company, Limited. George M. McNaughton is manager, and an average force of 25 men was employed during the year.

Sydenham Mica and Phosphate Mining Company, Limited.—The mica pit operated by this company in 1916 on lot 7 in the eighth concession of Loughborough township continued production till September, 1917, when work was stopped. The shaft was sunk about 50 feet, and the mica was trimmed at the company's shop in Sydenham. A hoist, gasoline engine and pump were installed.

The officers of the company are: Harry N. Kraft, president and treasurer; Jacob J. Stein, vice-president; A. B. Potter, secretary.

Molybdenite

International Molybdenum Company.—The only mine operated by this company in 1917 in Ontario was the Moran in Brougham township adjoining the O'Brien mine. Most of the ore mined was taken from an open cut, and the shaft was continued to a depth of 40 feet. The company is also a purchaser of molybdenite ores, having a custom concentrator at Renfrew and a smelter and refinery at Orillia.

At the concentrating plant at Renfrew three additional flotation machines were installed, and the capacity increased about 30 per cent.

The smelting plant at Orillia was operated for seven months when all equipment was transferred to a new plant, an additional electric furnace, new transformers and other equipment being added, thereby doubling the capacity of the old plant.

The officers of the company are: J. L. Murray, president; H. A. Jordan, secretary-treasurer and manager; B. C. Lamble, superintendent of smelter at Orillia; W. M. Weigel, superintendent of mining and milling. The head office of the company is in Renfrew.

The company manufactures molybdic acid, ammonia molybdate and ferromolybdenum.

Renfrew Molybdenum Mines, Limited.—The mine and concentrating mill of this company, situated on lots 8 and 9, concession XI, township of Brougham, operated continuously during 1917.

The officers of the company are: President, Jean Vanophen, 24 Rue Batallière, Paris, France; A. E. Goyette, vice-president, Montreal; secretary, R. LeAprohon; treasurer, P. C. Neault, Grand Mère, Que.; Chas. G. Titus, assistant vice-president and general manager, Mount St. Patrick.

During the year the 2-compartment shaft was sunk 75 feet to the 150-foot level, and about 600 feet of lateral development done.

Owing to lack of fuel for power, the mill ran only about 34 per cent. of the possible running time. The total production of molybdenite for the year was about 58,000 pounds. The concentrates averaged 95 per cent. MoS_2. A 96 per cent. recovery was made on ore averaging .74 per cent. MoS_2. The concentrates are shipped to France in barrels, the weight being about 1,000 pounds each. The mill has a daily capacity of 40 tons.

Owing to the difficulty of obtaining fuel, a transmission line was built to the power development on the Madawaska river at Calabogie and the plant electrified. One 5-h.p. and two 25-h.p. motors were added to the mill and a 100-h.p. motor to the compressor. Forty men are employed.

Spain.—The Spain mine, on lot 31 in the fourth concession of the township of Griffith, operated intermittently during the year. The production came principally from the open pit.

The mine address is Dacre, Ont., and the head office of the company is at 417 Fifth Avenue, New York. Ten men were employed.

Steel Alloys Corporation.—The Sunset mine, situated on lots 35 and 36, concession XIV, township of Brougham, is being operated by a company known as the Steel Alloys Corporation, of which H. E. Clarke, 27 William Street, New York, is president.

The ore body has been opened up by an open cut 10 feet wide, 100 feet long, the greatest depth of which is 35 feet.

The plant includes a 100-h.p. boiler, a 5 by 7 hoist and a 686-cu. ft. compressor.

J. E. Cole, Dacre, Ont., is superintendent.

Molybdenum Products Company, Limited.—This company has a capitalization of 1,075,000 shares of a par value of $1.00. The head office of the company is at Wilberforce. M. B. R. Gordon is manager, employing 10 men.

The mine is located on lot 33 in the sixteenth concession of the township of Monmouth in Haliburton county, about half a mile from the village of Wilberforce. A 75-ton mill is in course of construction.

W. E. Joiner and Company.—W. E. Joiner is opening up a promising molybdenite property on the north half of lot 3 in the twentieth concession of the township of Cardiff, 1½ miles east of the town of Wilberforce. The work so far done consists of stripping and blasting and has exposed some very fine molybdenite ore. A small steam plant is being installed.

Paudash Lake Molybdenite Mines, Limited.—Mr. Joiner has also done some work on a molybdenite deposit on lot 18 in the ninth concession of Cardiff, the Mooney farm, about 15 miles southeast of Wilberforce. This property is known as the Paudash lake molybdenite mine.

Wilberforce Molybdenite Company, Limited.—On lot 33 in the fifteenth concession and on part of lot 33 in the fourteenth concession of the township of Cardiff, the above company is opening up a molybdenite prospect. P. J. Dwyer is manager. A concentrator is being erected at Wilberforce.

Graphite

The demand for all grades of Ontario graphite was very satisfactory to the producers throughout 1917.

Since January 1, 1918, the crucible trade has fallen off materially owing to adjustments in the iron and steel business, and this in turn affected the demand for crystalline flake graphite and broke the market price for that product. The crucible makers; on account of a lack of demand for their product, demanded a higher grade of graphite. As a result the producers of crystalline flake in New York, Alabama and Pennsylvania had large quantities of this grade rejected, and the same condition prevailed with regard to the Ontario product.

The demand for lubricating flake has also fallen off to a considerable extent, and large stocks have accumulated.

With regard to the intermediate and low-grade graphite products, which are consumed largely by foundries and the iron trade, the demand has also materially fallen off since the beginning of the present year, owing to unsettled conditions in the iron industry in the United States. This state of affairs is due to the inability of the foundries to secure raw material for any but essentially war production.

The effect has been to put the small foundries devoted to commercial production practically out of business, and as they consumed the bulk of foundry plumbago for facing purposes, the demand has greatly fallen off.

Black Donald.—The Black Donald Graphite Company, Limited, had in 1917, the largest production of refined graphite in the history of the company. The mine and mill are situated about 14 miles from Calabogie, in Renfrew county. The company owns mining rights on lots 17 to 20 in the first, second and third concessions of the township of Brougham.

In the autumn of 1917 the open pit was lagged over, and work was continued throughout the winter in the old workings under Whitefish lake. The ore shoot has widened out considerably and continues to be high-grade milling ore.

New plant installations included three General Electric transformers, 4,400 to 550 volts; one Ingersoll-Rand compressor, 500 cubic feet capacity, one Universal jaw crusher. A new blacksmith shop and machine shop were built and equipped, and 33 dwellings for employees were erected during the year 1917. The hauling capacity to the track at Calabogie was increased by the purchase of five motor trucks, hauling from 2,500 to 3,500 lbs. each per load, and making two round trips per day.

The officers of the company are: R. F. Bunting, president; G. H. Bunting, vice-president; J. N. Snead, secretary; John Patno, superintendent; 75 men are employed at the mine and mill.

Globe.—The Globe Graphite Mining and Refining Company, Limited, operated their mine continuously during 1917. The mine is situated on lots 21 to 23,

inclusive, in the sixth concession of the township of North Elmsley, and the ore is teamed to the mill on the Tay river at Port Elmsley, a distance of three miles. Considerable diamond-drilling was done during 1917 by Smith and Durkee of Sudbury. No. 3 vertical shaft was sunk to a depth of 100 feet, with 40 feet of drifting to the north at the 60-foot level and 40 feet at the 100-foot level.

The mill is equipped with the dry process of concentration, using the Sutton, Steele and Steele tables and air flotation. In the spring of 1918 experiments were in progress for the installation of an oil flotation unit. The drying kilns were improved and a large Telsmith ore crusher was installed. When inspected, June 11th, 1918, work on the No. 3 shaft had ceased, and the old workings were being de-watered.

The company produces three grades of finished graphite designated as: M. flake, containing 90 per cent. graphitic carbon and over; F. flake, containing between 65 and 85 per cent. graphitic carbon; D. grade dust, containing from 30 to 40 per cent. graphitic carbon.

The officers of the company are: Chas. A. Lux, president; George G. Fryer, secretary-treasurer; George H. Beebe, manager, all of Syracuse. The head office of the company is 410 Dillaye Building, Syracuse, N.Y. George N. Brewer, Port Elmsley, is superintendent, employing 55 men.

National.—National Graphite, Limited, did a small amount of development work on their property on lot 24 in the thirteenth concession of Monteagle township; the mill at Munfords, near Harcourt on the I. B. and O. railway, is being remodelled at the present time.

W. A. P. Schorman is president of the company, the head office of which is in the Royal Bank Building, Toronto. George Gill is superintendent of the mine and mill at Munfords.

Corundum

Manufacturers Corundum.—The Manufacturers Corundum Company, Limited, mined various small deposits of corundum in the townships of Raglan, Radcliffe and Brudenel during 1917. Most of the operations were conducted during the winter months, and the ore was stockpiled at the company's concentrating plant at Palmer rapids on the Madawaska river, lot 24, concession XVIII, township of Raglan.

The officers of the company are: D. A. Brebner, Toronto, managing director; A. W. Holmsted, Toronto, secretary; H. E. T. Haultain, Toronto, consulting engineer; E. B. Clarke, Jewellville is superintendent, employing on an average 35 men.

Quarries

Canada Cement Company.—The quarry and clay pit operated by the Canada Cement Company at Point Anne near Belleville was closed for the greater part of 1917. On August 1 work was resumed and carried on till the close of the year, when it was again closed till March 1, 1918. The working face is now 50 feet in depth, and all drilling is done by two Loomis power drills, using a 5⅝-inch bit. The broken stone is loaded on 8-ton cars by a Marion steam shovel.

and hauled to the crusher by a dinky locomotive, on a standard-gauge track. The Fairmont jaw crusher has a capacity of 1,000 tons per day.

H. L. Shock is manager, employing 20 men.

Point Anne.—The Point Anne Quarries, Limited, operated continuously during 1917. Ground-storage capacity for 75,000 tons was installed during the year with belt conveyor to boats and cars. The quarry is one-half mile long by 300 feet wide. Drilling is done with an Armstrong power drill, the holes being six inches in diameter and drilled to an average depth of 32 feet. The material shipped varies in size from ½-inch screenings to 8-inch lump for blast-furnace work. The officers are: M. J. Harvey, president; J. F. M. Stewart, manager; A. N. Harnwell, secretary-treasurer; A. G. Bennett, superintendent.

Hydro-electric power is used throughout the crushing plant and quarry. Fifty men were employed during the year.

V.—SOUTHWESTERN ONTARIO

Quarries

Beachville White Lime Company.—The quarry and lime kilns operated by this company near Beachville, adjoining the property of the Standard White Lime Company, were in continuous operation during 1917. The limestone, which in this district has a very high lime content, is quarried in two benches with a total face of 28 feet. At present only the bottom bench 8 feet in depth is being worked. A large percentage of the output is shipped to the Cyanamid Company at Niagara Falls, and to the Hamilton blast furnaces.

The officers of the company are: M. S. Schell, president; J. W. Blow, secretary-treasurer; C. E. Downing, manager.

Forty-two men are employed.

Canada Cement Company.—The cement plant and quarry operated by this company at Port Colborne worked with reduced capacity in 1917, and closed down completely in January, 1918, due to power shortage. The plant is well located close to the source of power at Niagara, but the large number of munition plants in the district have gradually absorbed all available power and forced other industries to close.

The quarry has a working face of 20 feet, drilling being done with a power drill. The broken rock is loaded into cars by two Marion steam shovels, a third Vulcan shovel being used for stripping.

S. R. Preston is manager, and L. M. McDonald, superintendent.

Canada Crushed Stone Corporation, Limited.—The large quarry and crushing plant operated by this company near Dundas, in the township of West Flamborough, was in continuous operation throughout the year. Its output of crushed limestone is the largest in the Province. The quarry is now worked in two benches, with a total working face of 54 feet, drilling being done by Cyclone Electric power drills. A large percentage of the output is used for fluxing purposes by the Steel Company of Canada, Hamilton. No additions were made to the plant during the year.

C. M. Doolittle is president and general manager, and J. B. Hart secretary-treasurer and assistant manager.

Christie-Henderson.—The Christie-Henderson quarry near Milton in the township of Nassagaweya, concession two, operated for the greater part of the year. The quarry is 700 feet long, and the working face is 40 feet in height, the stone being quite uniform in quality. Grey lime only is manufactured. Only sufficient force is employed to keep one kiln burning, with an output of 20 tons per day.

D. D. Christie, Guelph, is president of the company, and David Henderson, Acton, is associated with him in the ownership of the quarry.

Elora White Lime Company.—The quarry and hydrating plant operated by the above company near Elora, concession XII, township of Nichol, worked with increased output during 1917. Fifty tons of white lime per day is burned in the kilns and practically the whole of this output is hydrated.

The quarry has a working face of 25 feet, and during the year a Cyclone drilling rig was added to the quarry equipment, and the plant equipped with new hydrating machines.

The company is owned and managed by the Alabastine Company of Paris. J. Cameron is superintendent.

Hambleton.—The quarry owned by Robert Hambleton, near Hagersville, in the township of Oneida, operated for a short period during 1917. For the past two years, the quarry has been closed except for short periods during which the crushing plant was in operation supplying stone for country roads.

E. Harvey and Son.—The quarry owned by E. Harvey & Son, at Rockwood, near Guelph, operated for nine months during 1917. One kiln with a capacity of 20 tons of grey lime per day was in operation.

E. Harvey is manager, employing 15 men.

Interprovincial Brick Company.—This company was one of the few brick companies in the Province to operate continuously during 1917. The pressed brick plant, working with reduced capacity, has an output of 22,000 per day manufactured from the red shales and clays which occur throughout Halton county.

The quarry has a working face of 15 feet.

The officers are: A. O. Dawson, president, Montreal; E. G. Glenn, secretary, Toronto; F. B. McFarren, manager; K. Stillwaugh, superintendent.

The quarry and plant are situated at Cheltenham village, concession V, township of Chinguacousy, and the head office address is 30 Toronto Street, Toronto.

Michigan Central Quarry.—This quarry near Hagersville was in steady operation during 1917, the entire output being used by the Michigan Central railway for ballasting track. The quarry is worked in two benches with a total face of 20 feet. In 1917, fifteen miles of track in the vicinity of Hagersville were ballasted with material from this quarry. D. E. Cronin is superintendent for the railway company, and 65 men are employed.

Milton Pressed Brick Company.—This company is one of the largest manufacturers of pressed brick in the Province. Operations were carried on continuously during 1917, although the output was curtailed, due to scarcity of labour. Plant No. 2 in the township of Nassagaweya, near the town of Milton, formerly owned by the Toronto Brick Company, was closed during the year, but plant No. 1 operated steadily. From the mixture of clay and Medina shales found throughout this district the company make red and buff pressed brick, rough texture rug and wire-cut brick.

The officers are: J. S. McCannell, president; A. W. Holmsted, secretary; R. Wheeler, treasurer; C. E. Hill, superintendent.

Oneida Lime Company, Limited.—On the townline between Oneida and North Cayuga townships near the village of Nelles Corners, the Oneida Lime Company operates a quarry for the production of silica sand. The silica rock overlies the limestone in beds varying in thickness from 4 to 14 feet. The rock is crushed, ground and washed for shipment to the glass trade and ferro-silicon plants.

In April, 1918, the Canada Crushed Stone Corporation took over the quarry under lease, and operations are now under the direction of Mr. Doolittle.

In 1917, about 18,000 tons of silica sand were shipped from this quarry. Thirty-five men are employed.

Patterson Sand Company.—This company, successor to the Clifton Sand and Gravel Company, Stamford township, operated continuously during 1917. Robert Patterson is manager, employing about 12 men.

Building sand and gravel for concrete work are shipped from the old workings. During the past few years a large trade has been worked up in moulding and pipe sands. The moulding sand is shipped to all parts of Ontario and even as far east as Quebec, while a large trade in New York State is also supplied.

Queenston Quarry Company.—The limestone quarry owned and operated by this company is situated near St. Davids in the township of Niagara, lots 47, 48 and 49. During 1917, the crushing plant ran for three months only, and for the balance of the year building and dimension stone was shipped. The building stone plant is equipped with a set of gang saws and diamond saw, and blocks of large proportions are cut to required sizes.

The crushing plant consists of one No. 5 Austin gyratory crusher, followed by a Simons disc crusher and screening plant.

Charles Lowrey is president and manager of the company, and T. W. McKeown, secretary; 25 men are employed.

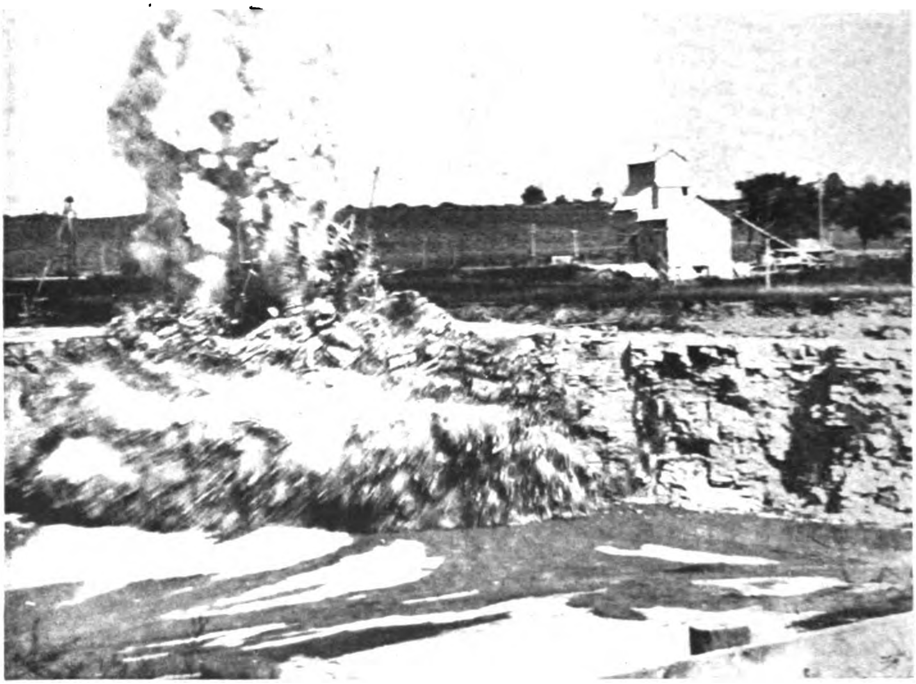
Robertson Quarry.—The quarry owned by D. Robertson & Co., Limited, lot 4, concession VII, township of Nassagaweya, operated continuously throughout the year. Work is being carried on in the extreme west end of the quarry, and the stone is hauled in carts to the kilns. Grey lime is manufactured, and only one kiln with a capacity of 20 tons per day is in operation.

D. Robertson, Milton, is president of the company, and J. R. Robertson, secretary.

F. Rogers and Company.—The quarry operated by this company is situated in Chinguacousy, on the east half of lot 30, concession VI, and the east half of lot 31, concession V. The chief production is in the form of flag stone, coursings and rubble stone. The quarry was worked during the summer months only because of slack demand in the building trade.

Dan Hastings is superintendent for the above company.

Standard White Lime Company.—This company, with headquarters at Guelph, operates quarries at Guelph, Beachville and St. Marys. White lime, high-grade fluxing stone, and hydrated lime are produced. At St. Marys, one kiln, with a



A blast at the quarry of the St. Marys Cement, Limited, resulting in 21,000 tons of broken limestone.

capacity of 25 tons of white lime per day, was in operation during seven months in 1917. The Guelph quarry and hydrating plant operated continuously with a working force of ten men. The principal operations of the company are carried on at Beachville, where two quarries are operated steadily. What is known as the West quarry produces stone for fluxing purposes, which is loaded directly into cars for shipment to Hamilton. This quarry has a working face of 25 feet. Stone from the East quarry is used in the kilns for the production of white lime. Two kilns, with a capacity of 20 tons per day, were in operation during the year.

The officers are: D. D. Christie, president; John Kennedy, manager; Wm. Culford, secretary-treasurer; W. P. Gamble, superintendent.

St. Marys Cement, Limited.—The quarry and cement plant owned by this company, formerly known as the St. Marys Portland Cement Company, was in steady operation during the year. By reason of power shortage the plant is now running at one-third capacity. Extensive additions to the crushing equipment were being installed in June, 1918. The No. 8 Kennedy crusher is being replaced by a 48 by 60-inch Blake jaw crusher, manufactured by the Taylor Engineering Company. This crusher has a capacity of 3,000 tons per day. Following the jaw crusher is a No. 7 Mammoth Williams hammer mill, manufactured by the Williams Patent Crusher and Pulverizer Company of St. Louis.

The officers of the company are: Geo. H. Gooderham, president; Hedley Shaw, vice-president; Mark Irish, secretary-treasurer; John G. Lind, manager.

St. Marys Horseshoe Quarry.—This quarry was operated for five months during 1917, the entire output being shipped to the National Portland Cement Company at Durham. Drilling is done by a power drill, the average hole being 40 feet deep, leaving a 4-foot bench at the bottom. The stone is crushed in a No. 6 Austin gyratory crusher, followed by a set of 22 in. by 24 in. rolls.

John Bonis is in charge of operations.

Toronto Lime Company.—The quarry owned by this company at Dolly Varden, concession IV, township of Esquesing, operated during the summer months of 1917. The stone is manufactured into grey lime, only one kiln being operated with a capacity of 15 tons per day. The quarry has a working face of 40 feet, and a much greater production could be maintained if trade were normal.

The Limehouse quarry and plant owned by this company were closed during the year.

The officers are: F. D. Brown, president; W. L. Scott, secretary-treasurer; W. Gowdy, superintendent; head office, 26 Queen Street East, Toronto.

Wentworth Quarry Company, Limited.—The quarry operated by this company is situated near Vinemount Station, T. H. & B. railway, on lot 4, concession V, township of Saltfleet. During 1917, operations were carried on continuously. The quarry has a working face of 19 feet, and drilling is done with a cyclone power drill. A set of Garfield rolls 42 in. by 16 in. has been added to the crushing plant.

F. W. Schwendiman is manager.

Gypsum

Ontario Gypsum Company, Limited.—This company is an amalgamation of the Crown Gypsum Company of Lythmore and the Alabastine Company of Caledonia.

The mine and grinding plant of the Crown Gypsum Company were not operated during the year. At the present time a shaft is being sunk beside the grinding plant at Lythmore to avoid the rail haul of 3½ miles from the old mine.

The Caledonia plant and mine operated continuously during the year, manufacturing hardwall plaster, plaster of Paris, land plaster and bug finish, supplying the markets of Ontario and Quebec, and shipping as far west as Winnipeg. The surplus is shipped to New York State.

The Carson mine is worked only during the winter months.

At the Caledonia mine the production is from the second, or 70-foot level, where the gypsum bed is about 6 ft. 6 in. in thickness. A third level, 14 feet below this, was opened up during the year, but this bed was only 4 feet thick. The production of this mine is about 200 tons daily.

W. C. Case, Buffalo, is president of the company; R. C. Haire, Paris, secretary-treasurer. The head office is at Paris and the works office at Caledonia. A. J. Parkhurst is general manager; about 75 men were employed on an average during the year.

VI.—Blast Furnaces and Refineries

Blast Furnaces

Algoma Steel Corporation.—The Algoma Steel Corporation has an authorized capital of 300,000 shares of a par value of $100 each. The officers of the company are: J. Frater Taylor, president; T. Gibson, secretary; J. Hawson, treasurer. These with the following constitute the board of directors: W. C. Franz, W. K. Whigham, H. Coppell and W. E. Stavert.

During the year 1917 a fourth blast furnace was installed; the No. 2 blast furnace of the Canada Iron Foundries, Limited, at Midland being purchased and re-erected at Steelton. This furnace has a capacity of 400 tons a day. The furnaces were operated continuously during 1917 as well as the Greenawalt sintering plant.

J. H. Bell is superintendent of blast furnaces, employing 300 men. V. H. Taylor is superintendent of the Greenawalt plant, employing 20 men.

Canadian Furnace Company.—The blast furnace of this company, situated at Port Colborne, operated continuously throughout the year with the exception of a ten-day shut-down due to coke shortage. Owing to the difficulties of securing a sufficient supply of coke, it was necessary to operate at a decreased production during part of the year.

The two large ore bridges were destroyed by wind-storms; No. 1 in October. 1917, and No. 2 in February, 1918; both are being rebuilt.

The officials of the company are: Frank B. Baird, president; Harry Yates, first vice-president and treasurer; C. A. Collins, second vice-president; F. C. Slee. secretary; B. Marron, manager; F. E. Deschenes, superintendent; D. J. Higgins. mechanical superintendent; 135 men were employed during the year.

The head office of the company is at 51 Hamburg Street, Buffalo, N.Y. The works office is at Port Colborne, Ont.

Steel Company of Canada.—Due to coke shortage, blast furnace "A" operated by this company at Hamilton was out of blast for 61 days during 1917. The larger furnace "B" operated continuously during the year. A large coking plant is in course of erection near the blast furnaces. One hundred and eighty-five men were employed in the blast furnace department.

Robert Hobson is president of the company; R. G. Wells, general superintendent; and Charles Grimes, superintendent of blast furnaces.

Standard Blast Furnace.—The blast furnace at Deseronto, owned by the Standard Iron Company, remained in blast throughout 1917. The Parry Sound furnace remained closed. Charcoal pig is produced at Deseronto, chiefly from Mesabi range ores, although some experiments have been carried on with a view to using Ontario magnetites.

The officers of the company are: R. J. Mercer, president; S. F. Belknap, secretary-treasurer; O. O. Laudig, works superintendent; 70 men were employed during the year. The head office of the company is at 318-321 Coristine Building, Montreal.

Tivani Steel.—The plant at Belleville owned by the Tivani Electric Steel Company was operated steadily during the year. The two electric furnaces, having a capacity of four tons each per day, and installed for the manufacture of tool steel, were used in the manufacture of ferro-molybdenum. At the beginning of 1918, owing to the scarcity of molybdenum concentrates, the manufacture of this product was discontinued, and the production of low phosphorus pig iron for munition work was undertaken. This has been successful. The charge consists of scrap—shell turnings—coke and lime.

Plans for a new 15-ton furnace, to replace the two small ones at present in use, have been drawn, and it is anticipated that this furnace will be in operation during 1918.

The officers of the company are: J. W. Evans, president; H. F. Ketcheson, vice-president; J. M. Wallace, manager; directors: R. J. Graham, H. Ackerman. H. F. Ketcheson, J. M. Wallace, J. W. Evans, J. A. McFee.

The capitalization of the company is $20,000, divided into 200 shares of $100 each, all issued.

Ten men were employed during the year.

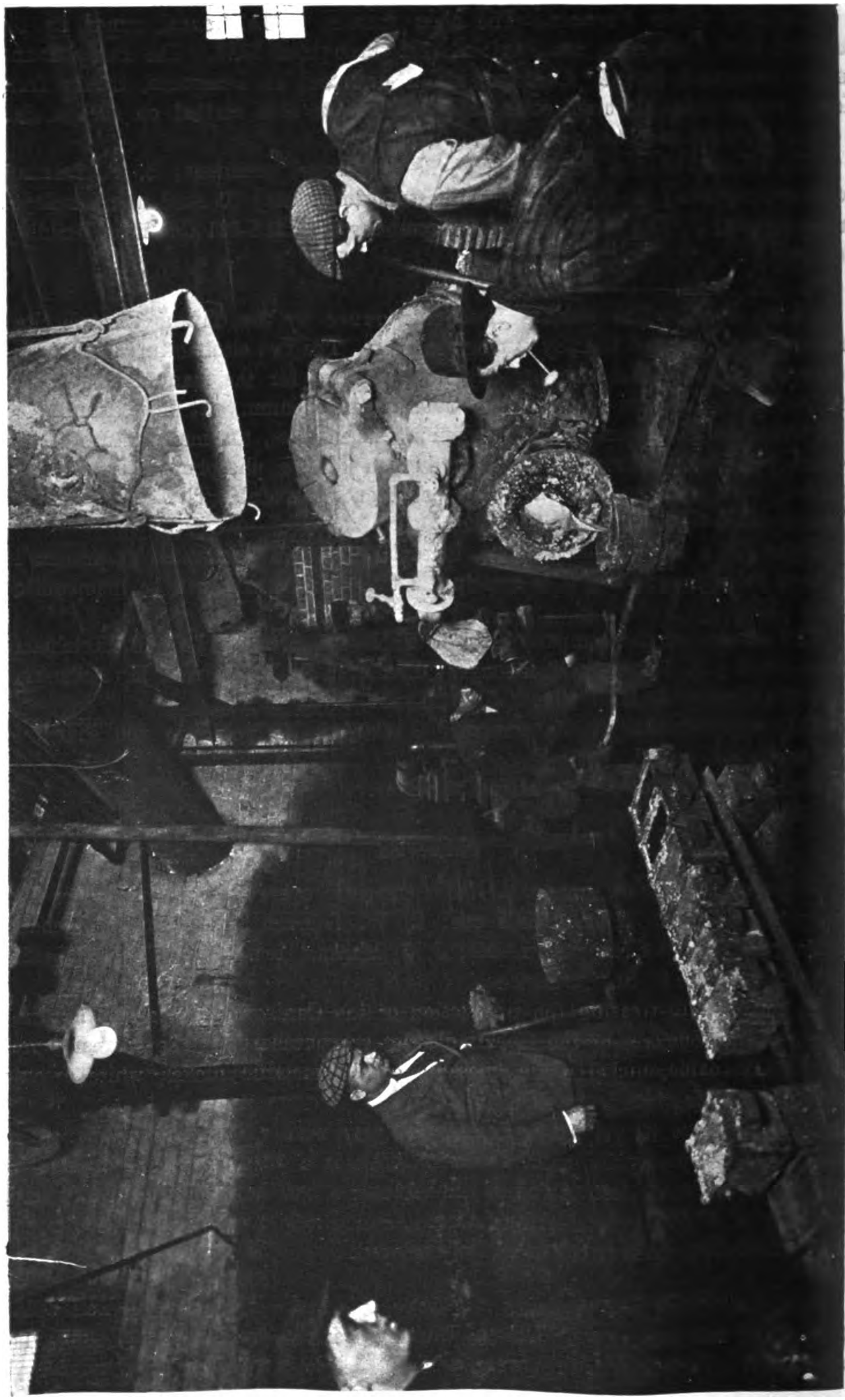
Refineries

Coniagas Reduction Company.—This company operates a silver smelter and refinery at Thorold. The officials are: R. W. Leonard, president and general manager; R. L. Peek, superintendent; J. J. Mackan, secretary. The head office of the company is in St. Catharines.

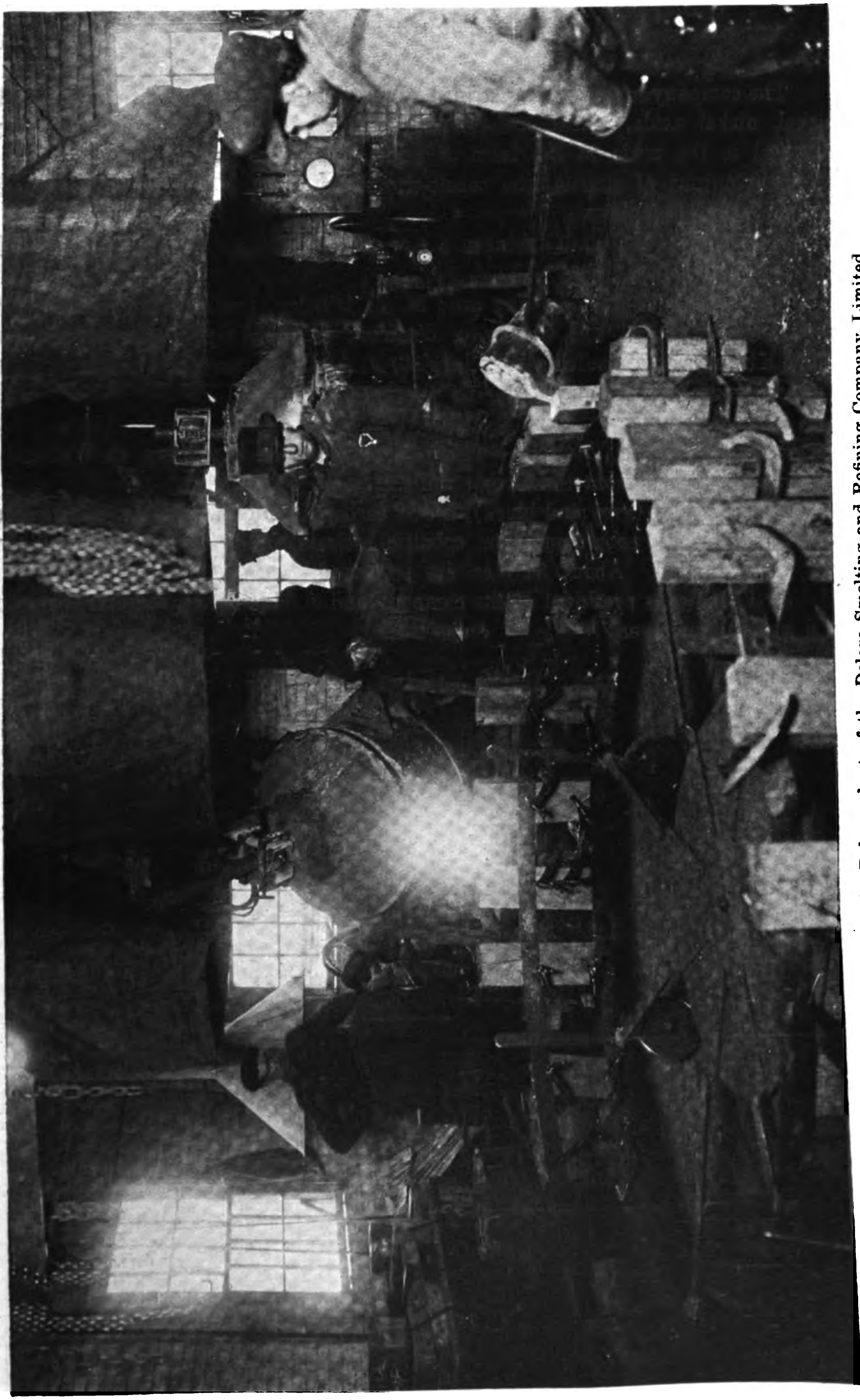
In addition to treating the production of the Coniagas mine and concentration works, custom ores of the Cobalt district are purchased. The company produces cobalt oxide, nickel oxide, metallic cobalt, metallic nickel, white arsenic and bar silver electrically refined.

The additions to the plant during the year were a Cottrell installation in connection with the speiss roast furnace. This is a 96-pipe treater capable of handling 15,000 cubic feet of fumes per minute; a new bag house was built with a capacity of 20,000 cubic feet per minute, and a new transformer added to the power sub-station. About 150 men are employed.

Deloro Smelting and Refining Company, Limited.—The smelting and refining works of this company at Deloro, Hastings county, operated to full capacity during 1917. Various additions were made to the plant with a view of increasing



Pouring silver at the Deloro plant of the Deloro Smelting and Refining Company, Ltd.



Casting "stellite" at the Deloro plant of the Deloro Smelting and Refining Company, Limited.

the output of manufactured metals and of providing facilities for experimental work in the metals branch.

The company manufactures refined silver, metallic cobalt, cobalt oxide, metallic nickel, nickel oxide, refined arsenic and stellite. Metallic cobalt and nickel are supplied to the trade in the form of grain, cube, shot and ingot.

The output of stellite, the cobalt-chromium-tungsten alloy, was greatly increased during the year.

Additions to the plant included a new office building, bag house, metal building and warehouses.

The officers of the company are: M. J. O'Brien, president; Thomas Southworth, vice-president and managing director; S. B. Wright, general manager; S. F. Kirkpatrick, consulting metallurgist; F. A. Bapty, secretary-treasurer. Four hundred men were employed during the year.

Metals Chemical, Limited.—This company operate a refinery at Welland on residues purchased from the Cobalt mills.

Nickel oxides (grey and black), nickel carbonate, nickel sulphate, cobalt oxides (grey and black), cobalt sulphate, cobaltic hydrate, crude arsenic and bar silver are manufactured. About 60 men are employed.

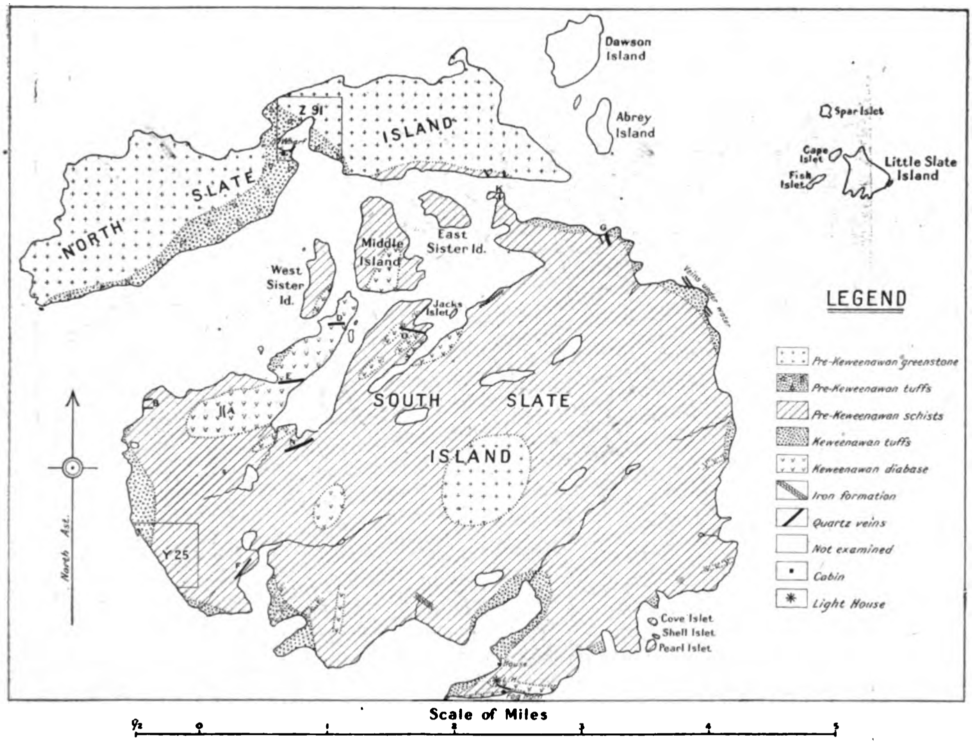
J. S. Gillies is president of the company and J. H. Charles, secretary-treasurer and general manager.

SLATE ISLANDS, LAKE SUPERIOR

By Arthur L. Parsons

Introduction

In view of the fact that several reports indicated that high-grade gold ore was to be found in considerable quantity on the Slate islands near Jackfish, the writer visited these islands twice during the summer of 1917 with a view of investigating the economic possibilities of the deposits. The first visit was solely



Geological sketch of Slate Islands, Lake Superior.

for the purpose of sampling the principal known veins, so that the later work might be carried out in a more intelligent manner. The second visit was made in the latter part of August and the first part of September, and comprised about two weeks' field work. At this time a more detailed study of the geology of the islands was made.

Considering the accessibility of these islands, remarkably little has been written concerning their geology; in fact, so far as the writer is aware, no attempt has been made to differentiate the various types of rock. This is less surprising when one sees the character of the rocks, for with few exceptions they are so decomposed and altered that it is extremely difficult to secure satisfactory specimens for study.

Location

The Slate islands consist of a group of some eight or ten islands located about seven miles south of the village of Jackfish on the north shore of Lake Superior. The total area covered by these islands is somewhere in the neighbourhood of 10,000 acres, of which about 2,000 acres are in North island and 7,000 acres in South island.

At the present time the islands are totally uninhabited except by the keeper of the lighthouse on the south side of South island, though some years ago there were mining camps at several locations on the islands.

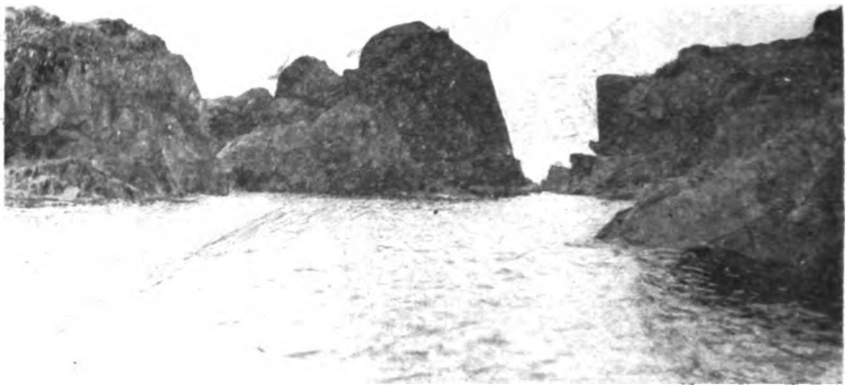


Fig. 1—Rugged shore, South Slate island.

Fig. 2—Southwest point of South Slate island, showing shoals.

A few years ago fire swept over a large portion of South island, so that the rugged character of the country is emphasized. On the unburned portion of this island as well as upon North island there is a good growth of the ordinary forest trees of this region, including spruce, balsam, Banksian pine, birch and poplar and some red pine.

Topography

The shore line of the islands is extremely rugged (fig. 1) and to a large extent precipitous, but in most cases no idea of the depth of the water at the base of the cliffs can be obtained, as is so frequently the case in regions where Keewatin rocks are prominent. Very frequently there is a broad irregular shelf of rock a few feet beneath the water's surface, and sometimes protruding above the water (fig. 2), so that it is extremely dangerous to try to keep near the shore in a boat except in calm weather. The rock has been much eroded by wave action, hence the shore is very similar to that in the Keweenawan rocks at Maimanse.

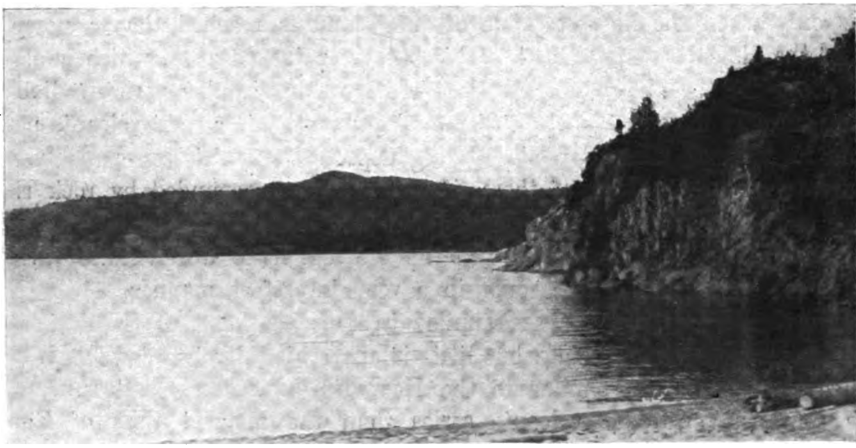


Fig. 3—Volcanic neck, South Slate island.

Fig. 4—Weathered diabase dike, South Slate island.

The surface of the islands is possibly not so rugged as might be expected in view of the character of the shores, yet on going to the highest peak of South island eight lakes were seen, while several others were found which are invisible from this point. Several of these lakes, possibly all of them, appear to be crater lakes, while the highest point on the island seems to be an old volcanic neck (fig. 3). Another similar volcanic neck is found near the northwest

point of South island. Dikes are frequent, and are often partially decomposed, leaving jagged peaks protruding above the ground level (figs. 4 and 5). The lighthouse is located upon the highest point of one of these dikes (fig. 6).

Geology

In general it may be said that there are two great epochs of rock formation represented on South island, though both appear to be volcanic. The rocks vary from the coarsest volcanic tuff to the most compact igneous rock. The older series appears to have been similar to the later one, but has been subjected to pressure so that schistosity has developed to a large degree. The remarkable variation in the character of the rocks presents a most complex problem in mapping, and it is only when the highest point of the island is reached that a possible solution of the difficulty is presented. This highest point (fig. 3), which is about 250 feet above the level of Lake Superior, is a roughly circular mass of diabase protruding through the surrounding schists and apparently is an old volcanic neck.

From its summit numerous lakes filling depressions which are possibly old craters are to be seen. Many of these, if not all, are surrounded by rock rims (figs. 7, 8 and 9). This volcanic neck suggests the probability that all the rocks on the island are of igneous origin, and the problem is to differentiate various volcanic flows. This can be done only in a very imperfect manner.

On North island the rocks are similar in type to those on South island, including grayish diorites and tuffs, but little if any schistosity has developed. In appearance these rocks are similar to the Keewatin greenstones and tuffs, and probably represent an older volcanic series than the mottled tuffs of South island. On the south side of the island some of the rock is schistose and is probably to be correlated with the schists of South island.

Exact correlation of these rocks with formations elsewhere is impossible, but from resemblances to other rocks and stratigraphic relations observed the following general order of formation is given:

Keweenawan: Diabase—volcanic necks and dikes.
Tuffs.
Pre-Keweenawan: Greenstones.
Tuffs.
Sericite Schists.

Keweenawan

Keweenawan Tuffs.—Near the shore of South island, but more particularly on the east, south and west sides, there are numerous outcrops of tuffs which are usually of mottled red and green colours. In some instances the fragments composing these tuffs are of enormous size (fig. 10) and the rock appears to be a conglomerate. Several of the pebbles were extracted from a decomposed mass of this type of rock, and in no case did they show signs of either water or glacial action, moreover, the fragments were all of one type of rock and although roughly angular showed a certain rounding of the corners that eliminated the possibility of the rock being a breccia. In most cases, however, the tufaceous character of the

deposits was remarkably distinct. These tuffs in all probability at one time overlay a considerable portion of South island, and at certain places on the west side of the island they are to be seen overlying the older schists on some of the high hills. At present, however, little trace of the later tuffs is visible except near the present shore line. It seems probable that much of the tuff has been removed by wave action at the time when some of the great gravel deposits along the north shore of Lake Superior were formed. This theory is further strengthened by the

Fig. 5—Diabase dike, showing jagged peaks due to weathering.

Fig. 6—Reef in front of Slate island lighthouse.

finding of large accumulations of worn pebbles of some of the more resistant rock of the island in some of the valleys above the present lake level.

Keweenawan Diabase.—The latest rock on the island is found in dikes and roughly circular masses which have every evidence of being volcanic necks. Whether these necks represent a molten mass which slowly cooled in the volcano or was extruded in a solid condition is a problem that is difficult to solve. In modern times the only recorded example of the latter type of volcanic eruption is the remarkable spine of Mt. Pelee, and in that case it is probably too soon to observe

certain phenomena that have an important bearing in the case under consideration. In certain instances the older rocks at some distance from the diabase are only slightly altered, and are principally granodiorites and diorites of a red or grey colour. These unaltered portions are, however, of very limited extent and near the shore where the less resistant altered material has been removed. In contact with the diabase the older rock is highly schistose, and nearly the whole mass of the older formation on South island is of this schistose character. Apparently

Fig. 7—View from Beacon, showing two lakes and bay.

Fig. 8—View from Beacon, showing four lakes.

this schistosity has been developed by the volcanic necks and dikes either from the pressure exerted by a mass of rock in cooling or by the pressure of a mass that was extruded in the solid condition. Where contacts were seen there is no particular evidence of thermal metamorphism such as is found in connection with the great dikes in the Lake of the Woods. The absence of the evidence of thermal metamorphism must be looked upon as presumptive evidence that the diabase was extruded at a temperature near the point at which it would solidify, so that

little heat was transferred to the adjoining rocks. The extraordinary shattering of the older rocks bespeaks a source of pressure not shown in the vicinity of dikes that have come under the writer's observation. In similar manner the same evidence of pressure is lacking in the few comparatively modern volcanoes which it has been his privilege to see.

In composition the diabase is of a normal type consisting of labradorite and augite, with a small quantity of ilmenite and possibly magnetite.

Pre-Keweenawan

Pre-Keweenawan Schists.—The main portion of South island and a part of the south shore of North island is composed of a schist which varies from a grey to cream-coloured sericite schist. In only a very few places is any trace of the original rock evident, but where seen, it is a diorite or a quartz diorite. Un-

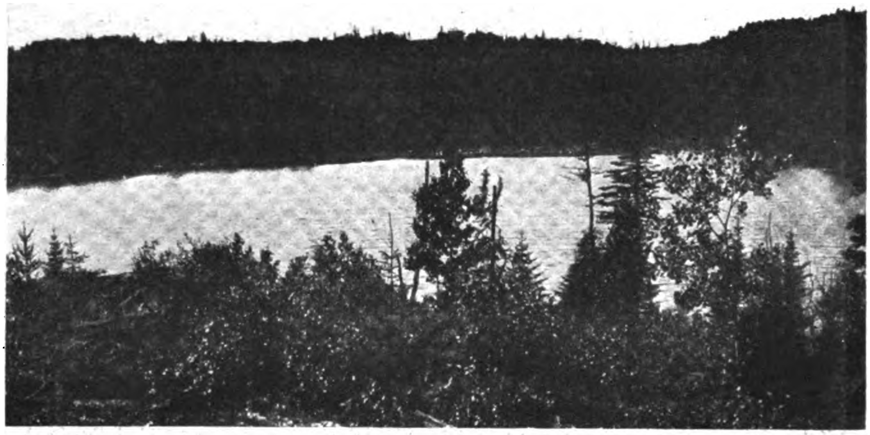


Fig. 9—Crater lake, west side of South Slate island.

doubtedly these schists gave the name to the islands, for although the rock is unlike slate in most respects, it has one of the most striking features of a slate in its easy separation into thin sheets. These schists are cut by the Keweenawan dikes and volcanic necks, but underlie all the other rocks.

Pre-Keweenawan Greenstones.—North island consists for the greater part of a greenish grey diorite, which in places exhibits pillow structure but more commonly is massive. In appearance and character of occurrence this rock resembles the Keewatin greenstones. In general the shore line is precipitous, and, unlike the shore of the south island, deep water is found even close to the shore. From a stratigraphic point of view it is not possible to assign a definite age to this rock, though it overlies the pre-Keweenawan schists which are so prominent on South island.

Pre-Keweenawan Tuffs.—Associated with the greenstones of North island is a considerable area covered by tuffs and breccias, which are petrologically similar to the greenstones. Near Copper Harbour on the south side of the island, these tuffs are cut by a diabase dike so that they are older than the latest rocks of the islands.

Iron Formation

Iron Formation.—On the northwest point of South island is a brecciated banded quartz rock (fig. 11) which resembles banded Iron formation. This is on the shore near the old tunnels which were driven on two veins for gold. In the more northerly of these veins a small quantity of jaspilyte was found accompanying the vein quartz, but a definite connection between this and the brecciated

Fig. 10—Tuff on east side of South Slate island.

rock was not established. In the case of the jaspilyte it was undoubtedly introduced after the development of schistosity in the rock, and is similar to the jaspilyte associated with crystallized hematite and vein quartz in small veins near Maimanse. A second outcrop of Iron formation is found south of the large volcanic neck near the south shore of South island. Neither of these outcrops, however, is of economic importance.

Age of Veins.—With but two exceptions, the quartz veins observed are situated either in the pre-Keweenawan schists or in the Keweenawan diabase. So far as those in the diabase are concerned, they must of necessity be referred to the Keweenawan or to a later period. Those in the schist are in most if not all cases to be referred to the period when schistosity was developed at the time of the

formation of the volcanic necks and dikes, the age of these veins in the schist being the same as that of the veins in the dikes. On North island two small veins were observed in the pre-Keweenawan greenstones and tuffs. For these it is not possible to definitely assign the same age, but as they are not far from outcrops of the older schist it seems reasonable to suppose that they belong to the same series of veins.

Fig. 11—Brecciated iron formation, South Slate island.

Economic Geology

Copper

On North island some years ago a prospecting tunnel was opened up on the shore of Copper Harbour, evidently with the idea of developing a copper prospect. No information concerning operations is available, and no trace of copper-bearing rock was observed by the writer. The rock through which the tunnel was driven is a volcanic tuff which might possibly carry copper, and it is probable that specks of copper were found to justify the development work, but as the property has been abandoned it would appear that no deposit of economic promise was encountered.

Iron

In former reports mention has been made of Iron formation and iron ore as float. Iron formation was observed in two places, but under conditions that appear to be connected with vein formation. No trace of workable deposits is evident.

Gold

On both the large islands, but more particularly on South island, there is a remarkable development of quartz veins which contain a greater or less quantity

Fig. 12—Old tunnel, northwest point of South Slate island.

of gold. Prospecting work has been done on several of these. In some of the veins rich specimens have been obtained, but so far nothing that would warrant the expenditure of any large sum of money has been found. Probably the richest vein on South island is located on the west side of St. Mary's bay. The various veins are indicated on the accompanying map by letters, and the description of the individual veins follows. All the assays were made by W. K. McNeill, Provincial Assayer.

A veins.—At the point marked A are two small veins just to the west of the high diabase knoll. These are about 8 feet apart, and are 8 inches and 5 inches wide respectively. They strike nearly north-south, and are therefore distinct from veins E and B which have been supposed to be continuous. No trace of a vein was found that would warrant such a supposition. Neither of these veins yielded either gold or silver.

B vein.—At the point marked B are two tunnels, the more northerly of which (fig. 12) is of interest, though the assays of the samples were disappointing. The vein is about 8 feet wide, and consists of white quartz on the south side, red jaspilyte on the north side, and rusty quartz in the centre. The vein is consider-

Fig. 13—E vein, South Slate island.

ably brecciated and is between schist walls. The principal interest in this vein lies in the jaspilyte associated with the vein quartz, which is suggestive in connection with the origin of certain iron deposits.

About 400 feet south of this tunnel is a second one beside a vein about 4 feet wide. In the roof of the tunnel several quartz stringers were visible, but none of these were an inch in width. The samples taken for assay from these veins carried no gold or silver, though the brecciated rock shown in fig. 11 yielded 40 cents in gold per ton.

D vein.—At D is a vein which varies from 4 to 8 feet in width. The quartz is well mineralized and shows some rusty weathering. The sample for assay was taken from a section 4 feet wide and included one foot of wall rock. On assay no gold was found.

E vein.—The largest vein observed is at the point marked E. It consists of white quartz in diabase, and is about eighteen feet wide (fig. 13). This was sampled twice the full width of the vein, but the results of the assays were negative.

F vein.—On the west side of St. Mary's bay is a vein with a width varying from 4 inches to 8 inches. In this vein visible gold was found, and samples the entire width of the vein were taken for assay. It is believed that these samples represent the maximum value that can be expected from any quantity of ore that might be mined from this vein. Selected samples might be taken which would yield much greater values. The quartz is white and milky, and the length as shown by numerous test pits is not less than 400 feet. Three samples were taken for assay, yielding $15.40, $0.00 and $3.20 per ton.

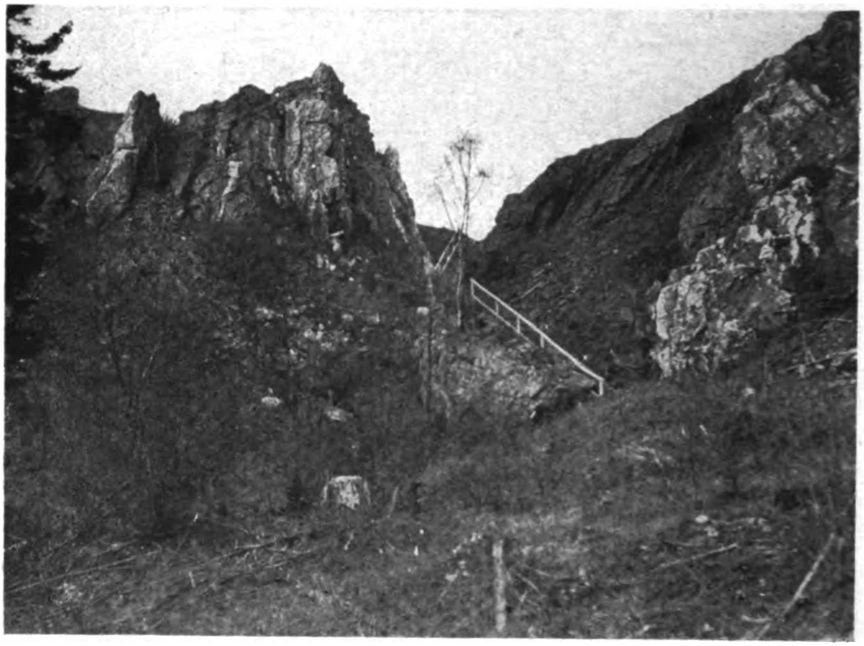


Fig. 14—Lighthouse veins, South Slate island.

G veins.—At the point marked G are two veins about 50 feet apart, the easterly one being 15 inches wide, the westerly one 2 inches. These were exposed on the rocky shore, but were not traced inland. No traces of old workings were found, though there is a record of work having been done. The larger vein gave on assay $1.60 and $2.40 per ton, while the smaller one yielded $2.60 per ton.

K vein.—At the point marked K on South island is a vein about 6 feet wide of rather bluish quartz, upon which several test pits had been sunk. In only one of these was it possible to see the vein material, but in this one the entire width of the vein was exposed. Private reports made to the former owner of the property indicate that this vein extends under water to North island. There is, how-

ever, at present no vein visible on North island that is of sufficient size to warrant the expenditure of much time or money in its development. Two samples were taken for assay, neither of which contained gold or silver. Samples were also taken from small veins on North island near this point, but in no case was gold or silver found.

Lighthouse veins.—Probably the most striking exposure of quartz veins on the islands is on the face of the cliff just below the lighthouse (fig. 14). At this point the vein system appears to consist of at least six distinct veins, though at a point possibly 600 feet east there is only one visible. The greatest width measured is 7 feet. Five samples were taken from various points for assay. One of these showed a trace of gold, the others nil.

N vein.—At N is a vein about 12 feet wide, though the walls are not well defined on the surface. This vein is nearly parallel with the southeast shore of the bay, and strikes approximately northeast-southwest. The sample yielded no gold.

O vein.—At the point marked O are some old test pits from which considerable quartz had been removed. The width of the vein could not be seen in these pits, but from the size of the material on the dumps it is at least a foot wide. One vein 4 inches wide was observed at this place. Two samples were taken, both of which were free from gold or silver.

MINERAL DEVELOPMENTS IN N.W. ONTARIO

By Arthur L. Parsons

Introduction

In accordance with instructions from T. W. Gibson, Deputy Minister of Mines, the writer devoted the greater part of the past summer to the examination of mineral deposits in western Ontario which were reported to be of prospective value in furnishing materials important for munitions.

The materials which received particular attention were copper, iron and pyrite. With few exceptions, deposits upon which development work was not in progress were not visited, though in certain cases where it was thought that valuable information could be secured such examination as was feasible was made. In addition to the above mentioned materials, samples were taken from two places on the Lake of the Woods for platinum assay with negative results.

On account of the nature of the work and the scarcity of help, it was necessary to depend largely on assistance that was cheerfully given by those interested in the properties examined. In particular the writer wishes to express his appreciation to Dr. W. L. Goodwin, Principal of the Kingston School of Mining, Col. S. W. Ray, of Port Arthur, and Dr. Warren Smith, Mokomon, Ontario, for assistance rendered not only by themselves but by those in their employ.

Copper Deposits

Owing to the high price of nearly every metallic product, the attention of prospectors and investors has been turned to the consideration of deposits which under ordinary conditions would not be considered of economic value. In several instances extensive low-grade bodies have been discovered, some of which will probably be worked long after the present stress is relieved. Among these products copper is most eagerly sought, and on account of the probability of the ore carrying values in gold and platinum, the probability of a stable foundation for the copper mining industry seems better than for most other metals. An important factor tending to retard the development of all but high-grade deposits, is the lack of a smelter or matting plant conveniently located with respect to known deposits in western Ontario, the consequence of which is that an unreasonable proportion of the returns for ore must be paid for freight charges.

During the past year copper ores have been shipped from two mines in western Ontario; the Tip Top near Kashaboiwe, and the Port Arthur Mining Company's at Mine Centre. In addition, considerable prospecting and development work has been done on properties near Lake Shebandowan and Mine Centre with more or less success.

The most extensive development is at the Tip Top mine, where a narrow gauge railway six miles in length has been built to haul the ore to the Canadian Northern railway two miles west of Kashaboiwe station.

Though the properties have many points in common, there is not sufficient information available at present to give a general description, hence each deposit is described separately. From the character of certain rocks at the Tip Top mine and from the geological relations of some of the copper-bearing rocks near Mine Centre, it would appear that there is an intimate relation between the copper ores and the Iron formation.

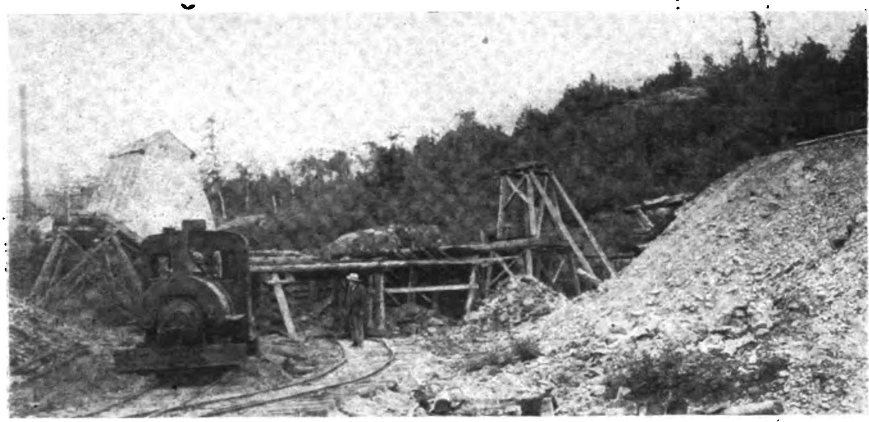


Fig. 1—Shaft house and sorting platform, Tip Top mine.

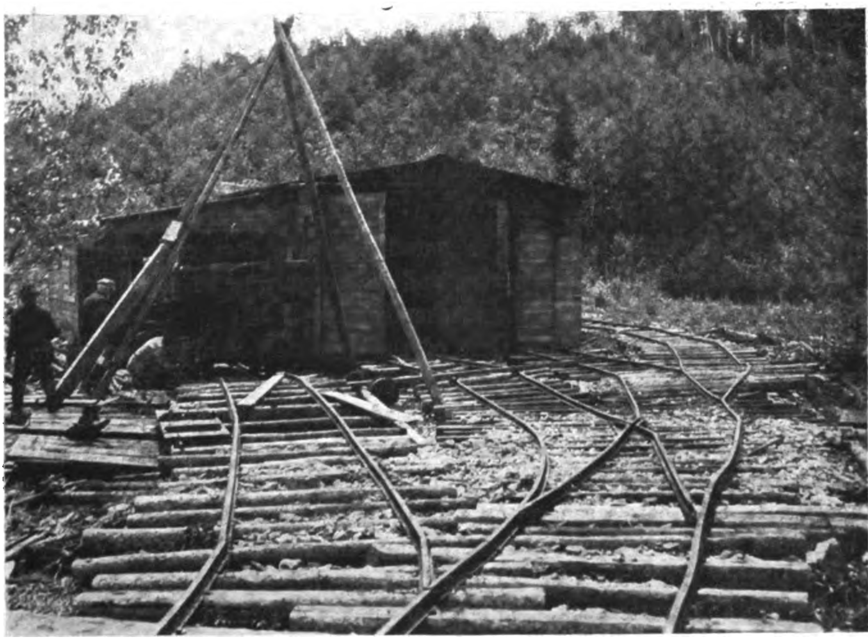


Fig. 2—Round house, Tip Top mine.

Tip Top Copper Mine

This mine is located near Round lake, and is sunk on a deposit of chalcopyrite and pyrite at the contact of Keewatin greenstone and sericite schist. Associated with the ore body and forming part of the sericite schist, is a large quantity of quartzose rock containing bluish quartz very similar to the quartz associated with the gold ores of the Laurentian, Ophir and St. Anthony mines. The main shaft has been sunk about 200 feet, and four levels have been opened. Only the first two were pumped out at the time of the writer's visit. On each of these levels two stopes have been opened, making 4,000 tons of ore available for mining. The principal vein is about 12 feet wide. The assay plan of the mine shows an ore chute about 150 feet long extending below the third level, but not yet proven on the fourth level. An examination of the drifts and stopes that could be inspected shows at least the quantity of ore above mentioned, but it does not appear to be definitely proven that the ore values cut off as indicated in the assay plan, since the main drift appears to leave the ore body to one side.

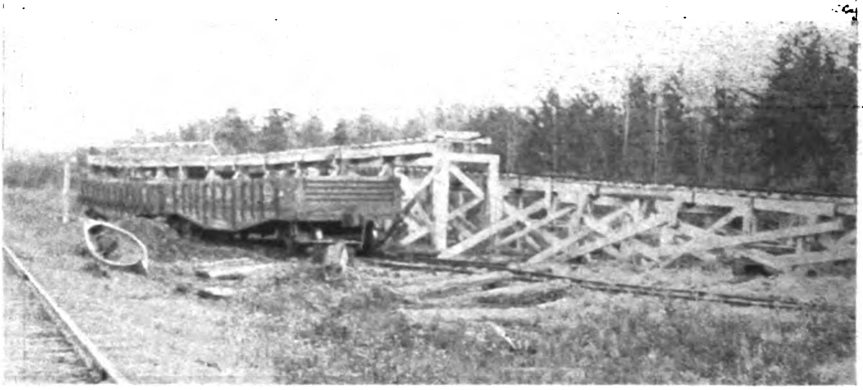


Fig. 3—Ore trestle, Tip Top mine.

A second vein about eight feet wide is found near the east end of the second level. This consists principally of pyrite, and is probably to be correlated with a rusty outcrop on the surface near the blacksmith shop.

Shipping was suspended at the time of the first visit in June, owing to the necessity of ballasting the narrow gauge railroad which connects the mine with the Canadian Northern railway. This railroad was constructed in the winter, and with the advent of spring a large force of men was employed in putting the track in shape so that shipments could be continued.

Since Dr. E. S. Moore's report[1] on this property there has been little change in the buildings and equipment except in connection with this railway. A new loading and sorting platform (fig. 1) has been erected at the mine to facilitate handling the ore and waste rock. This is of sufficient size to permit six 10-ton

[1] 20th Rep. Bur. Min., 1911, Pt. 1, pp. 210-13.

cars to be loaded before shifting. A building for storing the two small locomotives (fig. 2) has been erected near by. At the Canadian Northern railway a loading platform has been erected to facilitate the transfer of the ore from the narrow gauge cars to those of standard gauge (fig. 3).

Hoisting operations were recommenced on June 22, and continued during the summer, though much of the ore shipped was obtained from the old stock pile.

Fig. 4—Boarding camp, Tip Top mine.

Fig. 5—Manager's house, Tip Top mine.

In addition to the main shaft, three other shafts have been sunk to prospect the property, and considerable trenching has been done. The best showing obtained in this way is near No. 3 shaft. Good ore was taken from this shaft, which is at the side of a valley about 50 feet wide. Several trenches have been opened up in this valley, and in nearly every case gossan and chalcopyrite were found. In one trench considerable ore was taken out, possibly three or four tons, and

Fig. 6—Assay office and hoist house, Tip Top mine.

Fig. 7—Transporting men and provisions to Tip Top mine.

the indications point to a second ore body even larger than that upon which the most work has been done. This has been further confirmed by diamond drilling, and the writer was informed by the manager, Mr. Stewart, that about 25 feet of good ore was found in this way. So far as the writer could judge, this body of ore is distinct from the one upon which mining operations have been carried on.

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was discontinued about the first of July, and no one was on the property when the writer made his visit. The rock is similar to that on the property of the Port Arthur Copper Mining Company, being a sericite schist which is somewhat mineralized with pyrite and chalcopyrite. Some traces of malachite and azurite were observed on the dump, but the copper-bearing minerals were not particularly abundant. The accompanying view (fig. 10) shows the camps and one of the shafts.

Samson Walker's Claims.—About three-fourths of a mile east of Mine Centre, Samson Walker had a few men employed in sinking test pits in a somewhat

Fig. 10—Shaft and camps, Mathieu's claim.

brecciated schist. Although slightly mineralized, the deposits so far as developed do not appear to be valuable for copper.

Golden Star.—On the old Golden Star mining property two openings were made prior to the writer's visit on bodies of copper ore. In both cases the ore consisted of a mixture of chalcopyrite and pyrrhotite, and in many respects resembles the Sudbury nickel ore. The deposits are located in the greenstone and schists of Keewatin age, and in some portions exhibit a banding similar to that shown by the Keewatin Iron formation. In fact, it is probable that we have here a phase of the Iron formation similar to that shown on the west shore

of the lake, where it grades into a banded rock containing a greater or less quantity of chalcopyrite and other sulphides.

H. H. Wood was engaged in getting out a carload of copper ore, and later in the year made a shipment. At the time of the writer's visit the work was all confined to two open cuts, from 6 to 10 feet wide, the larger of which was about 30 feet long and 10 feet deep at the face of the working.

Laurence Hedburg's Claims.—About two miles east of Mine Centre, Laurence Hedburg was developing copper deposits on two claims, K 308 and H. P. 129.

On the first of these claims the ore consists of chalcopyrite associated with quartz interbanded with schist, forming a great fahlband. Some of the quartz bands are as much as 10 feet wide, and contain some siderite in addition to chalcopyrite and pyrite. The samples taken from this property are some of the

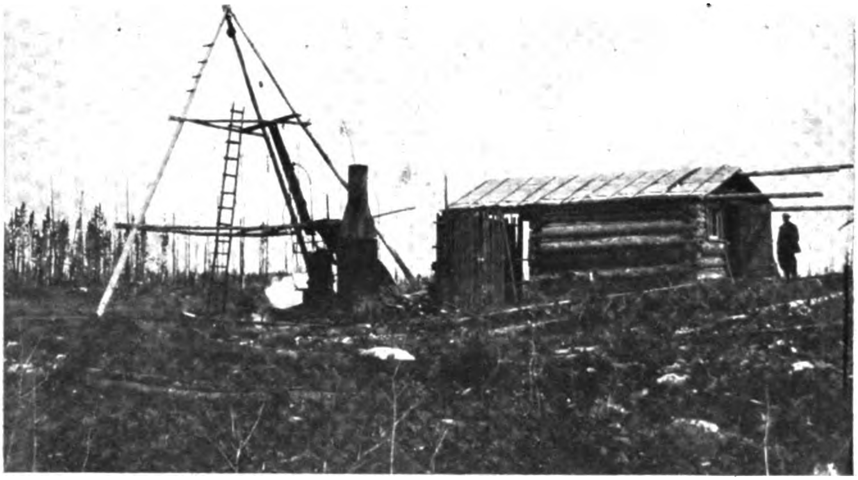

Fig. 11—Drill on H. P. 105, Mine Centre.

most attractive seen by the writer. These high-grade samples come principally from a band about a foot wide which would probably average more than 20 per cent. chalcopyrite in bulk. The claim should be further prospected.

On H. P. 129 Mr. Hedburg had just started work on a schistose amygdaloid which carries some chalcopyrite and some free gold. The writer found some visible gold in a small quartz vein about one inch wide which crosses the schist. At the time of the writer's visit the deposit was not sufficiently developed to enable an estimate of its economic possibilities to be formed. The ordinary rusty outcrop which is so common on deposits of sulphide ores is not prominent here. In this respect it is analogous to the deposits of the Port Arthur Mining Co. which were remarkably free from gossan.

Before an estimate of the value of the property can be made further development will be necessary. The almost complete absence of gossan makes prospecting exceedingly difficult, but it will be well to investigate the amygdaloidal rocks of this vicinity for further deposits of copper-bearing minerals.

International Copper Mining Co.—Under the name of the International Copper Mining Company, Messrs. Kennedy, Riley, Osborn and other gentlemen from Beaudette, Minnesota, were engaged in the development of a copper property on H. P. 105. This claim has been re-surveyed, and is now known as F. F. 387 and 388. A test pit had been sunk in a sericite schist which carried some chalcopyrite, and in some of the fissures erythrite or cobalt bloom was present. At the time of the writer's visit a diamond drill (fig. 11) was being used in the attempt to locate a body of richer ore than was found on the surface. The presence of erythrite gives encouragement to prospect further, since this is so commonly associated with silver ores. It is, however, an unusual mineral in association with copper ores, though in some of the Cobalt mines sulphides of copper have been found. Although considerable work had been done, a deposit that could be worked profitably had not been developed at the time of the writer's visit.

Lake Shebandowan Deposits

Having been informed that work had been done in developing copper and nickel deposits on lake Shebandowan, the writer attempted to find the workings, but as the nickel property was not on the lake shore and the boatman did not know where it was, it was impossible to locate it in the time at the writer's disposal. A small deposit of pyrrhotite not far from the location was seen, but the owner who was met later in Port Arthur confirmed the writer's opinion that this particular outcrop was not of economic importance.

About a mile east of the old Dawson road on the north shore of the lake, is an open cut partially filled with water, from which attractive specimens of azurite and malachite were taken. The work had apparently been abandoned for some time, and an examination of the dump failed to show any quantity of ore.

Mine Centre Iron Deposits

The principal deposits of iron in the vicinity of Mine Centre consist of titaniferous magnetite in which a certain percentage of vanadium is found. It was suggested by Dr. W. L. Goodwin, who was supervising the drilling of a considerable portion of the range, that it should be called the Fetiva range, thus indicating by the name the three prominent elements in the ore, iron (Fe) titanium (Ti) and vanadium (V).

Location

Extending along the northwestern shore of Bad Vermilion lake from a point about two miles from Mine Centre station on the Canadian Northern railway, is a precipitous cliff in which are located two or more parallel deposits of iron ore. By the use of the dip needle and magnetometer, as well as by the finding of outcrops, these deposits have been traced across the rolling country intervening between Bad Vermilion lake and Seine bay of Rainy lake, and thence along the north shore of Seine bay. The limit of the deposit on Seine bay was not observed by the writer, but he was credibly informed that at least one of the deposits outcrops near the mouth of the bay, giving a body of ore from 12 to 15 miles long.

Transportation

These iron deposits are at present reached in the summer by canoe or by a trip through the woods from Mine Centre. Part of the distance can be covered by a wagon road, and in conveying heavy supplies it would be necessary to extend this road. For actual mining operations, however, it would be necessary to put in a siding either from Mine Centre or Olive siding, so as to provide for the shipment of ore. Such a siding would involve the construction of four to six miles of track to reach the deposits that with present development appear to be the most promising. With further development, this could be extended parallel with the strike of the deposit so as to permit of working the deposit in several places.

Fig. 12—Outcrop of iron ore near Bad Vermilion lake.

Geology

The geology of the area covered by these iron deposits as well as the greater part of the Mine Centre copper deposits has been studied on two occasions by A. C. Lawson.[1] Unfortunately, that portion of the country to the northwest of Bad Vermilion lake was completely burned over a year or so ago, destroying large quantities of valuable timber. While this fire was a calamity so far as the loss of timber is concerned, it has given an opportunity of studying the geology that was not available when Dr. Lawson examined the region. The new information is incorporated in the accompanying map, which is based principally on Lawson's second one.

[1] G. S. C.. Vol. III, N.S., 1887-8, Pt. I, Sec. F., Report on the Geology of the Rainy Lake Region; also G. S. C., memoir No. 40, The Archean Geology of Rainy Lake Re-studied, 1913.

The most important alteration in the mapping is in connection with the granite, practically all of which is referred by the writer to the Algoman rather than to the Laurentian. This change is due to the contact relations shown at the Golden Star mine between the granite and the Seine conglomerate. At this place the conglomerate has been metamorphosed by the granite, so that there is a narrow band of schist at the contact of the two retaining the outlines of the pebbles of the conglomerate, though in other respects similar to the sericite schists in this and other pre-Cambrian regions. Another feature connected with this metamorphism, is an apparent impregnation of the conglomerate with a certain amount of the granite. This feature is discussed at greater length in the description of the Seine conglomerate. A similar feature was noted near the contact of the granite and the anorthosite areas. In certain cases the anorthosite was impregnated with quartz near the contact with the granite, so that it was not always easy to find the contact between the two.

The geological succession of the formations found in the area covered in this report and the descriptions of the copper deposits is as follows:

Granite and Granite Gneiss	Algoman.
Quartzite and Slate Conglomerate	Seine Series—Huronian.
Anorthosite Greenstones	Keewatin.

Algoman

Algoman Granite.—The Algoman granites have been most excellently described by Lawson, so that only a brief description will be necessary in this report. Formerly these granites were referred to the Laurentian, and it is only by observing the contact relationships that it is possible to assign a definite age to the great granite masses. Probably the best that can be done in most cases is to say that it is not later than a certain period.

The granites most closely observed were those around Bad Vermilion lake which are light in colour and moderately coarse grained. Dark minerals and sulphides are almost lacking, and the rock consists principally of quartz and plagioclase feldspar. Strictly speaking, therefore, it can hardly be called a granite, but approaches the quartz diorites. In places the feldspar has been partially altered to sericite, and at the contact of this rock with the overlying Seine conglomerate, molybdenite was found to which it is difficult to assign any other origin than the granite. The quartz in the granite has a peculiar bluish tint, but when observed in the rock in the field the mass appears to have a pale cream colour. This is possibly due to the presence of sericite which has resulted from the alteration of the feldspar.

Keewatin

Keewatin.—The Keewatin rocks of the area are of two general types, both of which have suffered alteration in certain places, giving rise to schists and para-gneisses whose origin is sometimes difficult to trace. These two principal types are anorthosite and greenstone, the latter being in some instances a more basic marginal phase of the former.

The main anorthosite mass is somewhat elliptical in form, and is roughly bounded by later granite masses. Along the southern border of the anorthosite no trace of a basic margin was observed, but occasionally quartz was found. At first it was thought that this indicated a crystallization of quartz from the molten anorthosite, but the impregnation of the Seine conglomerate at the Golden Star mine by granite, and the consequent enrichment of this rock in quartz, leads to the conclusion that the quartz present in the marginal phase of the anorthosite is due to the action of the later granite. On the northern edge of the anorthosite the rock becomes more basic and finally grades into an iron ore, but there is a less basic band as the northern granite is approached, and an enrichment with quartz similar to that seen on the southern edge. In the midst of the anorthosite

Fig. 13—Anorthosite enclosing diabase and granite fragments.

area is another mass of granite of the same petrological character as the outcrops to the north and south. The only other exposure of anorthosite observed was about a quarter of a mile west of Mud lake, where it assumes a peculiar mottled appearance. A feature of interest was observed at several places, more particularly on the west side of Outlet bay, where the surface of the anorthosite was covered by an igneous breccia, the fragments of which are principally diabase with an occasional fragment of granite (see fig. 13).

The essential difference between the anorthosite and the more common Keewatin greenstone lies in the presence of such minerals as hornblende, augite and biotite in the greenstone, thus giving rise to diorites and gabbros. These greenstones may be considered a more basic phase of the anorthosite.

By earth movements involving pressure and heat, both these rocks may be materially altered in structure and appearance. Schists of various types may be developed which, on account of the ease with which they permit the passage of solutions, are favourable to the formation of secondary ore deposits in veins and fahlbands. Large areas of these schists are developed near Mine Centre. In some cases they have been much crumpled after the original schistosity was developed. When such crumpling is found between comparatively straight bands, it is not always easy to comprehend the processes involved. A good example of this type of deformation is found just north of the Canadian Northern railway about a mile and a half west of Mine Centre. Here the pressure apparently has been applied from about N. 20°W., if we assume that the slaty cleavage is at right angles to the direction of pressure (see fig. 14).

Limestone.—In the Keewatin rocks near the Golden Star mine is a small outcrop of limestone which has been described in considerable detail by Dr. Lawson.[1] In certain portions there is crystallized magnetite and a rough banding suggestive of Iron formation. In many respects it is similar to the limestone associated with the Goudreau pyrite deposits, part of which has been shown by the writer to be a vein formation. In the present case it appears to be a tilted sediment, though bounded above and below by igneous rocks.

The Seine Series

Seine Series.—Inasmuch as the quartzites and slates of this series are not known in this region to be carriers of either iron or copper ores, the writer did not attempt to study them, but has accepted the former mapping.

In the case of the Seine conglomerate certain interesting features were observed, though the time devoted to examining this series was brief, seeing no deposits of immediate economic importance were reported from the region covered by it. In the conglomerate the pebbles are fairly representative of the older rocks and include granites, schists, greenstones and banded Iron formation. In the vicinity of Grassy lake the conglomerate has been squeezed so that it appears as a schist with "eyes" of harder rock, and it is not always clear that it is a squeezed conglomerate. A careful search, however, resulted in the finding of less altered material in which the rounded nature of the pebbles was still visible. The best exposure seen by the writer was about a half mile east of the Golden Star mine, where little if any metamorphism has occurred. The character of the rock is shown by the accompanying photograph (fig. 15). At the contact between the conglomerate and underlying granite at the Golden Star mine, there is an interesting phase which has been discussed by Lawson, and as one result of his interpretation of the phenomena observed the granite has been referred to the Laurentian. This contact phase consists of rounded pebbles more or less metamorphosed, with a matrix consisting largely of quartz, and other material derived from the underlying granite. To this type of material he has given the name "fanglomerate."

[1] G. S. C. Memoir 40, p. 44.

When the writer saw the rock in the field, it appeared to him to be a conglomerate that had been impregnated for several feet with molten granite; under such conditions the granite would be referred to the Algoman series of Lawson. A study of thin sections, both of the granite and the contact phase of the conglomerate, gives evidence that is strongly confirmatory of this interpretation, though in many respects the material is very unsatisfactory. The granite is composed of quartz and feldspars, principally plagioclase, with very little of the common dark minerals. In places the feldspar has been partially altered to sericite, which is possibly the cause of some of the creamy colour seen on a weathered surface.

The conglomerate in this contact zone presents several points of interest. It consists of pebbles from half an inch to four inches in diameter, that for the most part have been water-worn. Between the pebbles there is an abundance of

Fig. 14—Sericite schist, showing secondary crumpling and development of secondary slaty cleavage, Mine Centre.

Fig. 15—Seine conglomerate near Mine Centre.

quartz which has been more or less corroded, and is enclosed in a ground mass that appears to be sericitic. No feldspars were recognizable. Associated with this interstitial material pyrite and molybdenite were recognized, not only in the thin sections but with the naked eye. These sulphides are present only in the interstitial material and not in the pebbles. If this deposit were formed in the manner suggested by Lawson, it is difficult to conceive of conditions that would preserve the molybdenite without visible alteration. Molybdenite is one of the minerals that is seldom if ever found except as a result of igneous intrusion, though frequently it is in rocks that have been metamorphosed by such intrusion. As a result of the presence of this mineral, and in spite of the otherwise unsatisfactory character of the thin sections, the writer is referring the Bad Vermilion granites to the Algoman series rather than to the Laurentian.

Iron Ores

The iron deposits are intimately connected with the anorthosite and gabbro, and are located not far from the granite area which parallels the northwest shore of Bad Vermilion lake and Seine bay of Rainy lake. Near Bad Vermilion lake two workable bodies of ore are present, and occasionally a smaller third one is found; but in the covered region near Seine bay it has not been definitely shown that there is more than one. The ore appeared to be magnetite, though a portion of it was stated by Dr. Goodwin, who was developing the properties, to contain a considerable percentage of titanium and some vanadium. Through Dr. Goodwin's courtesy the writer was enabled to make a microscopic examination of one of the drill cores with a view to determining the relations existing between the ore and the adjoining rock. Several schistose bands were cut by the drill, and it was thought desirable to ascertain whether these represented different types of original rock, or were merely shear zones in the anorthosite-gabbro. Unfortunately, none of the drill holes started in the pure anorthosite, but the relationships are such that there is little doubt that the gabbro is merely a more basic marginal phase of this rock. With the exception of two slides in which the minerals could not be definitely identified by the microscope, the core appears to be divided mineralogically into three distinct portions which are still genetically related, and with the exception of the richer ores all the rock showed plagioclase feldspar or some of its alteration products. A further exception is made of the afore-mentioned two samples where the minerals could not be identified.

The first 67 feet appears to be normal gabbro, and schist derived from gabbro, and is characterized by the presence of plagioclase, calcite and hornblende or biotite, with minor quantities of pyrite and magnetite.[1] In the next 173 feet the character of the rock differed in two respects: augite was the predominant dark mineral, and ilmenite with its decomposition product leucoxene was present as a rock-forming mineral. Pyrite and biotite were present rather uniformly. From this point to the bottom of the hole at 384 feet, augite was lacking, though biotite or chlorite was present in nearly every section. Magnetite[1] was present in every section but one, and ilmenite and leucoxene were not found. A mineral which came as a surprise in connection with the ore bodies was apatite, which was in well formed crystals surrounded by magnetite. The microscopic examination would tend to the supposition that the ore would be rather high in phosphorus. It is also possible that when more material for examination can be secured, the apatite may prove to be the source of the vanadium that has been reported from these ores. This seems probable, as there is no other source indicated by the minerals present in the sections, and vanadium and phosphorus have similar chemical relations.

[1]The analyses made later and given in the text indicate that the mineral recognized as magnetite is in nearly every case ilmenite. In the ore body leucoxene was absent, so that it was not possible to make a distinction between the two minerals, magnetite and ilmenite. The analyses strengthen the supposition that the ore is due to magmatic segregation. On account of the lack of definite chemical formulae for the minerals hornblende, augite, biotite, and chlorite, it has been impossible to make a calculation showing the percentages of these minerals in the rocks.

The ore is in many respects similar to the celebrated Kiruna ores in Sweden, but the associated rocks are very different; the Kiruna ores being immediately associated with syenite porphyry and quartz porphyry. Another more nearly related series is found in Nelson county, Virginia, where ilmenite and apatite form a rock or ore mass which appears much the same in hand specimens as the Kiruna ores.

Origin of Iron Ores

The iron ores of this range have a peculiar interest among Canadian ores, as they furnish a type of deposit which is important in other regions but has not been noted before in Canada. Being associated with great masses of anorthosite, and containing neither siderite, hematite nor limonite, it appears to owe its origin to igneous causes. The one feature favouring a sedimentary origin is the great length of a comparatively narrow band of iron ore. So far as microscopic examination has shown, there is no accompanying rock to which a sedimentary origin could reasonably be assigned. When other similar deposits are recalled—magnetite and titaniferous magnetite containing more or less apatite associated with anorthosite—it seems reasonable to look upon the ore as a magmatic segregation.

Representative samples were taken from the drill core for analysis to show not only the quality of the ores, but to get further light on the genesis of the rocks and ores. The analyses have been made by W. K. McNeill, Provincial Assayer with the following results.

Analyses of Samples from Drill Core, W. L. Goodwin Property, Bad Vermilion Lake

No.	Depth feet	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	H_2O	CO_2	TiO_2	P_2O_5	V_2O_5	S FeS_2	Total.
1.....	2	44.14	12.47	5.07	6.72	10.30	1.98	3.50	0.27	2.03	7.20	0.00	....	....	FeS_2 6.67	100.35
6.....	64	36.66	14.14	3.93	11.63	11.13	7.84	1.52	0.22	5.41	5.51	Tr	....	....	S 2.12	100.13
9.....	79	45.34	21.26	5.39	5.23	7.72	4.06	4.24	0.29	3.34	2.68	....	0.08	....	S 0.73	100.36
12.....	93	37.92	18.75	10.56	12.61	4.96	3.78	0.75	Tr	5.02	2.33	2.10	....	....	S 1.37	100.15
19.....	130	45.32	20.77	3.23	8.73	7.10	6.72	0.99	Tr	4.89	1.91	....	....	....	....	100.17
29.....	180	40.34	22.89	2.15	16.16	3.15	4.01	2.02	Tr	6.77	2.19	0.20	0.07	....	....	99.95
36.....	253	37.68	21.25	0.65	15.27	8.65	3.14	1.01	Tr	5.66	4.85	0.35	1.78	....	....	100.29
37.....	260	4.28	43.67	3.35	22.38	6.15	0.43	0.64	Tr	2.58	0.81	14.40	1.35	Tr	....	100.04
38.....	276	10.10	21.46	2.73	34.88	1.85	2.20	0.42	Tr	2.14	1.00	23.44	0.06	0.11	....	100.39
42.....	299	29.80	27.46	1.80	15.28	4.50	3.63	3.58	0.09	4.52	4.50	5.06	Tr	....	....	100.22
45.....	356	6.74	5.34	16.08	39.13	0.50	0.75	0.41	Tr	1.84	0.79	27.52	1.10	0.09	....	100.29
46.....	358	7.60	13.92	9.77	35.80	1.90	3.01	0.67	0.27	2.12	0.88	24.88	....	0.08	....	100.90
48.....	371	11.67	36.44	5.77	24.47	5.50	3.18	0.64	Tr	2.51	0.38	4.92	1.70	Tr	....	100.18
49.....	377	12.08	33.30	6.37	28.09	5.25	3.18	0.70	0.20	3.15	0.36	5.78	1.69	Tr	....	100.35
50.....	384	14.00	25.18	3.29	27.25	6.20	1.53	0.80	0.62	3.11	5.37	5.80	1.51	Tr	FeS_2 5.06	99.72

Pyrite Deposits at Mokomon

About a mile from Mokomon station on the Canadian Northern railway extensive development work was in progress during the past season in proving the extent of some pyrite deposits on lot B, concession V, Conmee township. The work consisted principally of trenching and diamond drilling. Over a large portion of the property there is a very deep overburden, so that geological boundaries could not be readily seen, and the writer was informed by the former owner of the property that he traced these deposits by means of a dip needle where they were not in evidence on the surface. This use of the dip needle at first seems surprising, as pyrite is one of the minerals which does not affect the dip needle to any extent. It is, however, worthy of note that in most places where pyrite is present

Fig. 16—Pyrite deposit near Mokomon.

there is also some pyrrhotite and possibly magnetite, both of which are magnetic, so that it may be desirable to give more attention to dip needle reading in prospecting even for sulphide ores.

In trenching it was found necessary in many places to sink to a depth of forty feet through a hard boulder clay which required very little timbering. By means of the trenches and the diamond drilling five deposits were proven, and as a result the property was taken over by the Nichols Chemical Company during the winter.

The rocks on the property appear to be principally Keewatin greenstones with some rhyolitic portions, and in a few places a conglomerate was uncovered which is probably to be correlated with the Seine conglomerate. These rocks containing

the pyrite deposits rise quite abruptly from the Kaministiquia valley, along which may be seen a comparatively level terrace which appears in part to be connected with the flat-lying Animikie deposits that are better exposed a few miles nearer Port Arthur.

Details of the extent of the deposits could not be given at the time of the writer's visit, but the accompanying photograph (fig. 16) of a quarry face on one of the deposits will give some idea of size.

Lake of the Woods

In view of the scarcity of platinum and the consequent extremely high price of this metal, the writer was instructed by the Provincial Geologist to examine any known serpentine deposits in the western part of the Province to ascertain whether there might be a source of platinum in this region. Two deposits of serpentinous rock had been observed by the writer in his earlier work on Lake of the Woods, both of which are easily accessible, one being a copper-bearing rock on Allie island, and the other a serpentinized dike in the Welcome channel. These were both visited the latter part of August and samples of about 100 pounds were taken from each place. The samples were sent to W. K. McNeill, Provincial Assayer, but both yielded negative results.

OGAHALLA TO COLLINS

On the National Transcontinental Railway, Ontario

By Percy E. Hopkins

Introduction

The following report gives the results of an examination made during June and July, 1917, along the line of the National Transcontinental railway for a distance of 175 miles between Ogahalla station, at the crossing of the Kenogami river, and Collins station, which is located on Trout lake some 30 miles northwest of Lake Nipigon. The route over this railway from Winnipeg to Cochrane is described in Guide Book No. 9 of the International Geological Congress, 1913, by Messrs. A. G. Burrows, W. H. Collins and M. E. Wilson. In that report the central portion of the route is described only in a general way owing to the line of railway not being finished at that time; hence these notes will add to the information contained in the guide book. In addition, some exploratory canoe trips were made inland for the purpose of inquiring into the mineral possibilities of the areas. A pyrrhotite deposit on Pine lake was examined, and water routes not previously mapped between Smooth Rock, Caribou and Round lakes were investigated. The sketch maps accompanying the report were prepared by Messrs. W. J. Bell and P. A. Jackson of the Bureau of Mines staff. The assays mentioned in the report were made by Messrs. W. K. McNeill and T. E. Rothwell of the Provincial Assay Office.

Ogahalla to Cavell

A. G. Burrows when examining the line of railway in 1912 was able to get as far west as the Kenogami river, a large picturesque river famed for its speckled trout and sturgeon. From Kenogami river to Cavell and on to Kowkash station, (fig. 1) may be spoken of as the western part of the northern Ontario clay belt, These clays were probably deposited in lake Ojibway. Associated with the stratified clays are varying amounts of boulder clay, sand, gravel, peat, erratics and frequent exposures of hornblende and biotite granite and granite gneiss, which make the area on the whole unsuitable for agricultural purposes. It is, therefore, considerably rougher than the vast clay belt which extends from the Kenogami river easterly into the Province of Quebec. Cutting the Laurentian gneiss at mileage 111.7 (fig. 1) is a narrow Keweenawan (?) diabase dike. Grant, a divisional point on the railway, is surrounded by grey granite gneiss which is cut by red granite. South of Grant on Pine lake is a large pyrrhotite deposit carrying low values in copper, nickel and gold. The deposit is referred to in more detail in a following paragraph. From Opemisha to Paska station, a distance of 40 miles, there are extensive sand and gravel deposits with numerous kettle lakes, representing probably a pause in the front of the great ice sheet which at one time covered this whole area.

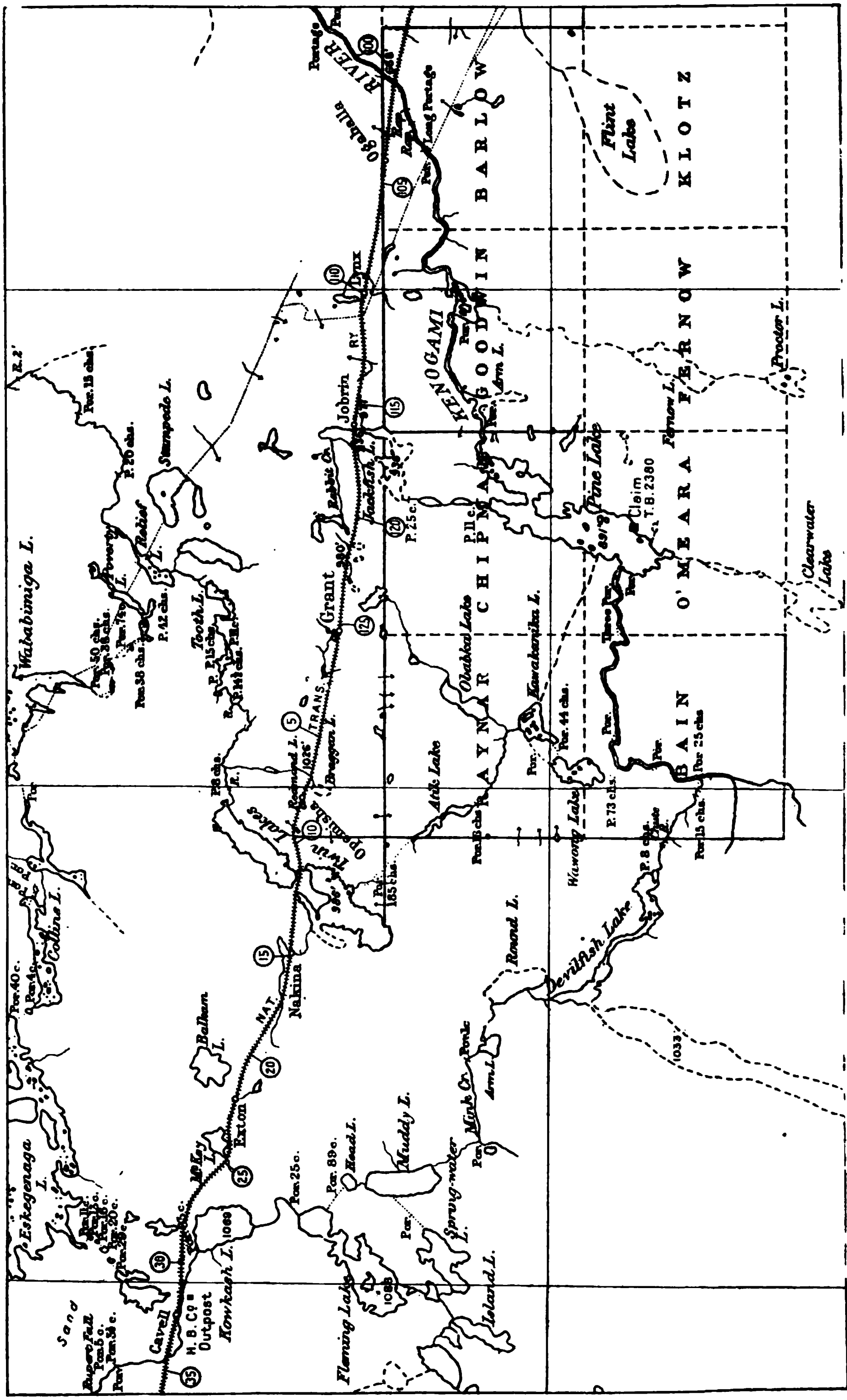

Fig. 1—Route map between Ogahalla and Cavell stations, N. T. Ry. Grant is a divisional point. Every 5-mile post on the railway is shown. Scale, 8 miles to the inch.

Cavell to Ombabika

For the route between Cavell and Ombabika the reader is referred to the report and map of the Kowkash Gold Area.[1] The rocks here belong largely to the Keewatin complex, consisting dominantly of basalt, quartz porphyry, slate and Iron formation. There has been considerable work done on gold prospects at Howard falls, 9 miles north of Kowkash and in the vicinity of Tashota. At the present time (April, 1918) this work seems to have been discontinued. Iron deposits were also investigated in 1906 and 1907 on the Onaman iron range, near where Paska station is now situated. Some promising-looking iron pyrites deposits also occur in the area. The railway crosses the height of land, altitude 1,118 feet, one-half mile to the east of Redmond. To the east of this watershed, the waters drain northward into James bay while to the westward they drain into Lake Superior.

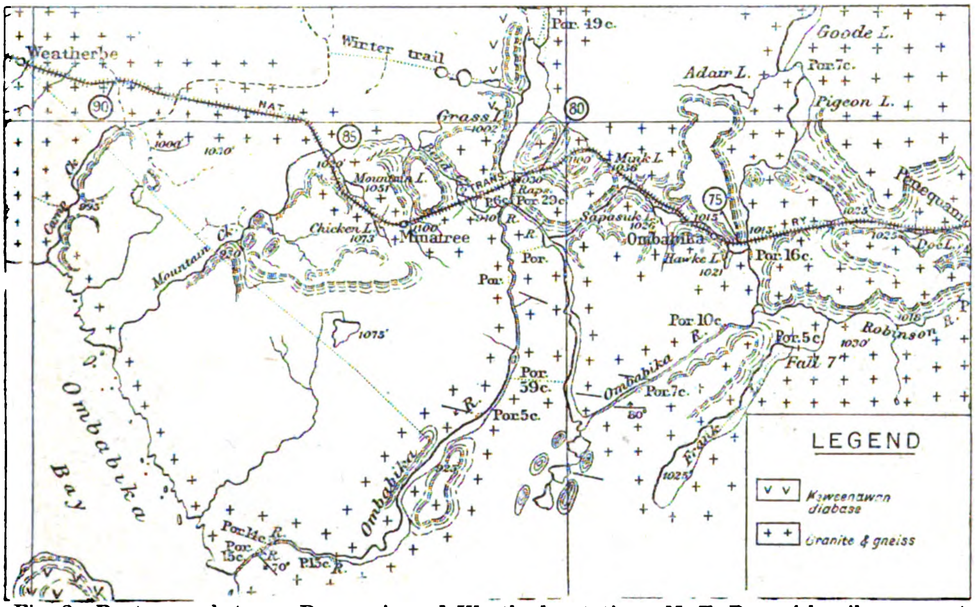

Fig. 2—Route map between Penequain and Weatherbe stations, N. T. Ry., with mileages west of Grant. Base from Map No. 8A, Geol. Sur. Canada. Scale, 4 miles to the inch.

Ombabika to Collins

The Ombabika river is a well-travelled route which is used in going from Lake Nipigon to the Albany river, and thence to James bay. Practically the whole distance from Ombabika to Collins, as shown by figs. 2, 3 and 4, is underlain by Laurentian hornblende, biotite granite gneiss and some younger granites, and overlain with small remnants of Keweenawan conglomerate and sandstone, which are in turn capped by diabase. The area on the whole has been burned, giving it a bleak appearance. Considerble drift, consisting chiefly of stratified sand and clay, occurs between mileages 104 and 127. The deposits, which are at least

[1] Ont. Bur. Mines Report, 1917, Vol. XXVI, pp. 190-226.

100 feet in thickness as seen in some of the stream beds, were probably laid down in glacial Lake Warren that formerly occupied the Lake Nipigon basin. Near Weatherbe, at mileages 91.3 and 93.3, narrow dikes of diabase cut the grey hornblende gneiss. Lake Nipigon can be seen from the railway only at a few intervals in the vicinity of Ferland. Mileage 102, immediately west of Ferland, is spoken of as "the summit." At this point the railway passes through

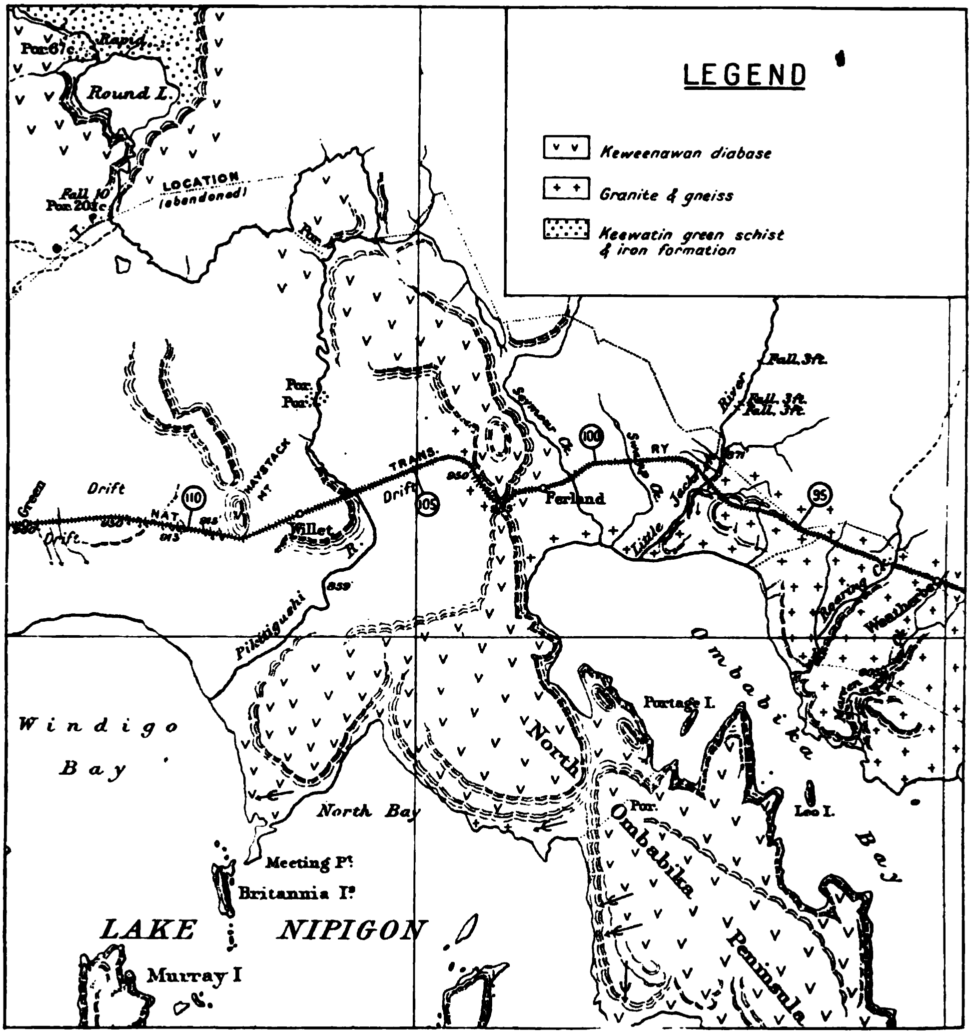

Fig. 3—Route map between Weatherbe and Green stations, N. T. Ry., with mileages west from Grant. Scale, 4 miles to the inch. Base from Map No. 8A, Geol. Sur. Canada.

a gap in a prominent north and south ridge of Keweenawan diabase whose southerly extension forms the prominent North Ombabika peninsula, on Lake Nipigon. Immediately west of the ridge can be seen the underlying gneiss. The railway crosses the Pikitigushi or Mud river near Willet at mileage 106, this point being 7 miles by river from Windigo bay, the northwestern part of Lake Nipigon. The fact that this is the only stream navigable for launches between

the railway and Lake Nipigon will tend to make Willet an important place for tourists or anyone wishing to communicate with Lake Nipigon. About the only rock exposure in this vicinity is a conspicuous, conical-shaped hill of Keweenawan diabase known as Haystack mountain, which is situated one mile west of Willet north of the railway. The hill has an altitude of 1,266 feet by aneroid, and may be seen from many parts of Lake Nipigon, 30 to 40 miles distant. It is the intention of the Ontario Government to build a look-out tower on this hill for use in connection with its forest protection system.

The Whitesand river is crossed at mileage 123.3. Speckled trout may be caught in this river, as in most streams between Ombabika and Collins.

Armstrong is a divisional point surrounded by granite, gneiss, conglomerate, sand and boulders. The massive, fresh-looking granite, at a point on the railway five miles west of Armstrong, contains large inclusions of hornblende granite gneiss, showing that the granites are of two ages. A knoll of reddish Keweenawan conglomerate may be seen lying on the gneiss about 100 yards south of the town. Molybdenite is reported to occur in patches in the granite on some of the islands in Tunnel lake about two miles south of the railway, while float containing molybdenite was also reported to have been found on Trout lake near Collins. A thin sheet of diabase, only a few feet thick in places, lies on the granite gneiss in the vicinity of Pascopee station between mileages 13 and 15. This diabase can be traced southeasterly for 25 miles to Lake Nipigon, the sill increasing to 400 or more feet in thickness as Lake Nipigon is reached. From Pascopee to Collins and for many miles to the west granite gneiss is the prevailing rock.

Armstrong and Vicinity

The geology in the vicinity of Armstrong was examined while making a track survey of several lakes, viz.: McLaurin, Mackenzie, Mattice, Castle and Pillar. Brook trout are plentiful in many streams connecting these lakes. Much drift, especially sand, occurs in the area. The underlying rock is Laurentian granite and gneiss, as may be seen at numerous places along the railway. Lying on the gneisses are occasional thin horizontal beds of conglomerate and sandstone. (See fig. 4.) A few hundred feet south of Armstrong the conglomerate is at least 20 feet thick, and contains numerous round and angular crystalline fragments. The conglomerate and red sandstone on the shores of Pillar lake lie under and adjacent to a diabase sheet which is at least 250 feet thick. The diabase overlies all the other rocks in the immediate vicinity, and is the prevailing rock. It is 200 or more feet in thickness, and has a characteristic, vertical, columnar structure. This jointing is most beautifully shown on the shores of Castle lake, 7 miles southwest of Armstrong, where many of the vertical columns have fallen over. Frequently isolated columns present castle-like effects, as shown in the accompanying photographs (figs. 5, 6, 7 and 8). Numerous calcite stringers carrying considerable pyrite occur on the east and west shores and near the extreme south end of McLaurin lake. These narrow veins range up to three inches in width and cut the massive diabase at various angles. Samples from several of the veins, however, were found on analysis by W. K. McNeill to contain no silver.

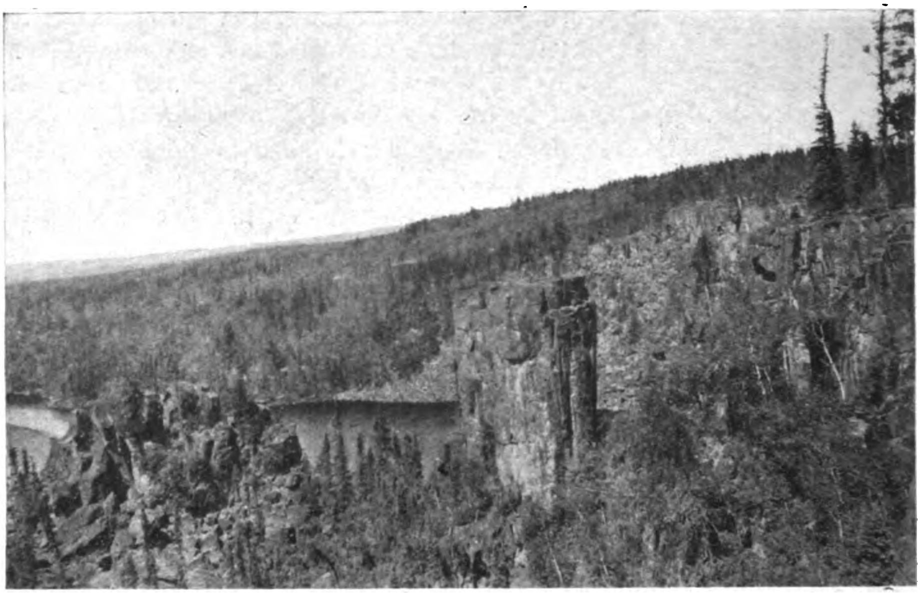

Fig. 5—General view of Castle lake and vicinity.

Fig. 6—Columnar diabase rising about 200 feet above Castle lake.

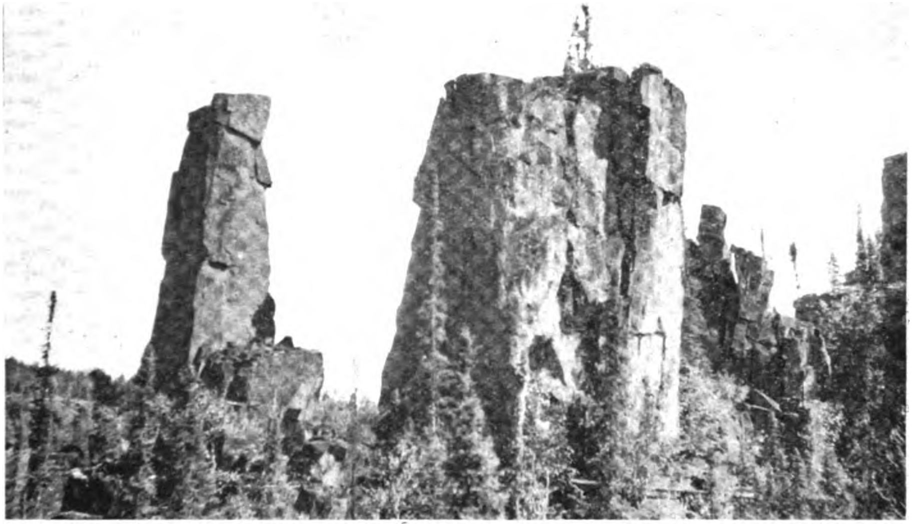

Fig. 7—View at close range of some of the diabase pillars on "Castle Hill," Castle lake.

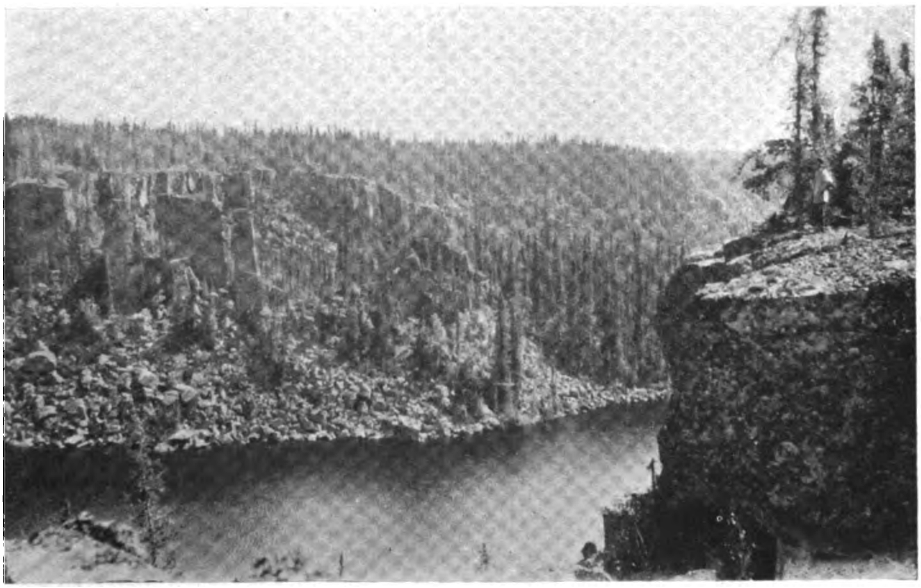

Fig. 8—Columnar diabase on Castle lake, eight miles southwest of Armstrong station.

Molybdenite on Tamarack Lake

Six miles north of Collins station on the northeast shore of Tamarack lake, and less than a quarter of a mile from the portage which runs from the lake around a falls at the mouth of the Boiling-sand river (fig. 4) molybdenite occurs in a coarse flesh-coloured biotite granite or pegmatite dike, which is at least 20 feet wide and intrudes biotite granite gneiss. A sample containing molybdenite was found on analysis to carry no gold. Although the molybdenite occurs disseminated through the rock in flakes up to one-quarter of an inch across, yet the mineral did not appear to be present in economic quantity. However, the locality might be a favourable one in which to do some prospecting, since no trenching had been done.

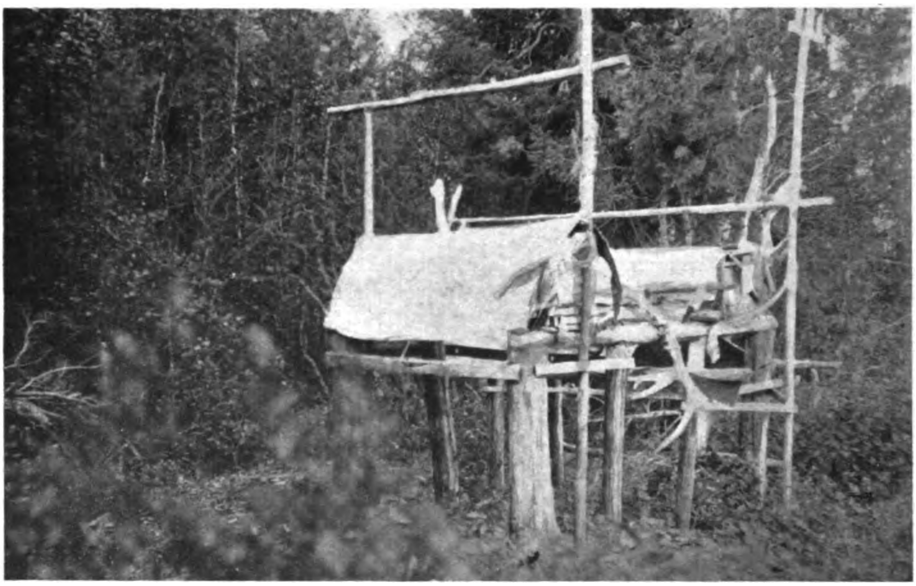

Fig. 9—Indian graves on Smooth Rock lake. The coffins are placed above ground and are covered frequently with canvas. July, 1917.

Smooth Rock Lake

Smooth Rock lake, shaped like a huge devilfish, is some 25 miles across and contains many islands. The general character of the shores and islands is low, almost continuous rock with little soil covering, and the timber recently burned, consequently, there are few black flies or mosquitoes in the area. Exploration party No. 7 of the Ontario Department of Crown Lands, in charge of H. P. Proudfoot, O.L.S., with F. J. Snelgrove as geologist, passed through Smooth Rock lake in 1900, made a micrometer-log-compass survey of part of the lake and found the geology to consist of Laurentian hornblende granite gneiss.[1]

Lying on or cutting the gneiss on the north shore and halfway down Lone Breast bay is an olivine diabase, probably a sill remnant, 200 feet in height. Under the microscope the labradorite laths are set in a groundmass of augite containing

[1] Report on Exploration of Northern Ontario, 1900.

numerous grains of olivine and much magnetite. Some miles farther west at the narrows of the same bay is another outcrop of Keweenawan (?) diabase. Between these outcrops of diabase there is hornblende schist cut by a massive grey biotite granite. An island in Lone Breast bay to the south of the olivine diabase hill consists of banded "sugary" quartz, and pyrite striking nearly east and west and dipping vertically. The rock resembles portions of the altered Iron formations on Caribou, Round and Marshall lakes. The guide, Alfonso D'Alton, stated that similar rock occurs on the first small lake northeast of the outlet of Lone Breast bay, and on the west side of Outlet bay, Smooth Rock lake. The writer was also informed that Lone Breast bay drains by a large river and three lakes with three portages on the route, northeasterly into Whitewater lake. This being the case, Smooth Rock lake has at least three outlets. Smooth Rock lake is 20 feet lower than Caribou lake, as determined by the drop in the falls and rapids on Caribou river which connects the two lakes. The writer made a track survey of the east bay of Smooth Rock lake, Caribou river and Outlet bay of Caribou lake. The four short portages on Caribou river are over Keweenawan diabase, the remainder of the route being through Laurentian granite gneiss and pegmatite.

Caribou Lake

A micrometer-compass survey of Caribou lake and a geological examination of its shores and islands were made by W. H. Collins[1] in 1906. The writer spent two or three days on the lake before examining the area to the east between Caribou and Round lakes. The outlet bay or commencement of Caribou river which had not been previously mapped is surrounded by granite and gneiss (fig. 4).

A portion of the northeast end of the lake was examined. Here two small lakes, one of which is called Fletcher lake, drain from the north into a long bay on the northeast end of Caribou lake. The rocks in the vicinity, as shown in fig. 4, consist dominantly of Keewatin pillow lavas, with some narrow bands of Iron formation, quartz porphyry, hornblende schist and rusty carbonate, striking a little north of east. The Iron formation consists of alternate bands of magnetite, usually an inch or two in width, and sugary quartz. Collins refers to a band of magnetite 12 inches wide from this vicinity. In places much iron pyrites occurs in the formation, but neither iron nor iron pyrites were seen in economic quantity. The quartz porphyry contains numerous quartz and some feldspar phenocrysts, and resembles the quartz porphyries accompanying the Iron formation in Deloro township and in the Onaman and other iron ranges. Capping these older rocks in places are Keweenawan diabases, the conspicuous outcrop being known as Kellar's peak, which is at least 400 feet high. Four miles southwest of Kellar's peak and on the northeast end of an island which is at least one mile long is a quartz vein, six inches wide, containing copper pyrites. A sample from this vein yielded on assay 80 cents of gold to the ton. At the extreme northeast end of Caribou lake is a portage 25 chains long which passes over a water divide. The rocks on this portage are hornblende gneiss and quartz-porhyry schists, which strike east and west and dip 70 deg. to the south, and may represent a recurrence of the Laurentian.

[1] A Geological Reconnaissance of the Region traversed by the National Transcontinental railway between Lake Nipigon and Clay lake. Can. Geol. Surv. Report No. 1059.

Caribou Lake to Pikitigushi River

For some time rocks belonging to the Keewatin complex have been known to occur on Caribou lake and 18 miles to the southeast in the vicinity of Round lake, but little has been known of the intervening area. A. W. G. Wilson, however, found these schist rocks to continue across the interval between the northeast end of Caribou lake and Pikitigushi river.[1] The writer made a track survey and geological examination along a chain of lakes and streams through this area, which resulted in the delimiting of a portion of the south boundary of the Keewatin area as shown in fig. 4. This route commences by a small portage which leaves Caribou lake at a point approximately six miles from its northeast end. The portage passes over the height of land into a small pond which drains by means of streams and lakes easterly into the Pikitigushi river at a point about ten miles above Round lake.

The Keewatin rocks in this area consist of massive and schistose diabase and greenstone rocks which frequently show the ellipsoidal structure. In addition to green schists there are hornblende, chlorite and talc schists, rusty carbonates and Iron formation. These rocks strike from northeast-southwest to east and west, and usually have a vertical dip. The Iron formation, which consists of sugary quartz and magnetite, occurs in bands up to 50 feet in width, at frequent intervals from the west side of Caribou lake to Round lake. One of the richest outcrops seen occurs on the south central shore of Moon lake, but nowhere did the iron appear to be in commercial quantity. In places, viz.: on Fletcher, Michell and D'Alton lakes, the Iron formation is accompanied with varying quantities of iron pyrites, as is frequently the case in other parts of the Province. The outcrop of sugary quartz on the southeast shore of Michell lake is at least 500 feet long, 3 feet wide and contains about 50 per cent. of disseminated iron pyrites. Fuchsite, a chromium-muscovite, occurs in bands up to a foot in width near the same locality.

Quartzose schists, resembling Lawson's Couchiching series and the Marshall lake series, occur at the 25-foot falls on the west end of Pawshowconk lake, also near the northeast end of Caribou lake and on Lone Breast bay, Smooth Rock lake. Moore[2] describes similar rocks with the Iron formation at Round lake.

Cutting the old rocks at the east end of Michell lake and in the vicinity of Fuchsite and Cumaway lakes are numerous, narrow quartz porphyry intrusions post-Keewatin in age. Under the microscope the white-weathering porphyries are seen to contain numerous quartz, feldspar and biotite phenocrysts in a micro-crystalline groundmass of the same composition. Quartz veins, varying from a few inches to two feet in width and carrying iron pyrites and copper pyrites, were seen in the area. A sample from a vein near the rapids between Michell and Fuchsite lakes gave on assay 40 cents of gold to the ton. It would appear that this particular area is worthy of prospecting for gold, since gold-bearing veins are frequently found in a similar association of rocks throughout many parts of central Canada.

[1] Memoir No. 1, Geology of the Nipigon Basin, Can. Geol. Surv., p. 51.
[2] Ont. Bur. Mines Report, Vol. XVIII, 1909, Pt. 1, p. 158.

Three small areas of hornblende granite and gneiss occur in the area, viz.: at the first portage between Caribou lake and the stream running into Michell lake, and on the southwest and southeast shores of D'Alton lake.

Lying unconformably on the old Keewatin on Moon lake is a small area of nearly flat-lying conglomerate and grey sandstone at least 10 feet in thickness. The conglomerate contains well-rounded pebbles consisting of white quartz, Iron formation, granite gneiss, etc., embedded in a greywacké groundmass. The sediments are probably Keweenawan in age, since they resemble the isolated patches to the south in the vicinity of Lake Nipigon. The exposures on Moon lake are the most northerly known Keweenawan sediments in the Lake Nipigon basin.

Capping all the rocks referred to above is the diabase of the Nipigon sill. A prominent ridge or sill remnant passes all the way from the Pikitigushi river across the south sides of Reef and D'Alton lakes, and probably joins up with the diabase on the southeast shore of Caribou lake, fig. 4. Much of this ridge was burned over in the summer of 1917.

A few calcite veins up to one foot or more in width were seen conforming with the strike of the Keewatin schist on the islands and shores of Reef lake. No metallics were noticed in the veins, and samples from three different veins show the absence of silver on assay; nevertheless, the presence of such veins in a formation quite similar to that at Cobalt might warrant some of these calcite veins being prospected for silver. According to an old Indian report, silver was obtained from a calcite vein projecting out of the water on Reef lake at a point near where the river enters from Moon lake.

Pyrrhotite on Pine Lake

Pine lake, an expansion of the Kenogami river, lies about eight miles southeast of Grant station. The rocks surrounding the lake consist chiefly of Laurentian (?) hornblende granite and gneiss. These are cut by massive red biotite granite and a few narrow dikes of diabase, probably of Keweenawan age. On the southeast shore of the lake on claim T. B. 2390, (fig. 1), are three parallel bands of pyrrhotite which have been referred to by E. V. Neelands.[1] The deposits occur in a hornblende gneiss, strike slightly north of west for 100 feet and dip vertically. The south vein, which is at least 10 feet wide, consists of massive, granular pyrrhotite with a little pyrite and disseminated grains of quartz or chalcedony. A chipped sample across 10 feet yielded on assay[2] the following: Nickel 0.14 per cent.; gold 40 cents per ton; copper, none, and platinum, none. The middle band, which lies 50 feet to the north, is approximately six feet wide, and consists dominantly of pyrrhotite with some pyrite and a little disseminated molybdenite. The northerly deposit, 100 feet from the middle one, is about 10 feet wide and contains some pyrite and chalcopyrite. A few samples from the latter body yielded on assay[3] the following: Copper 0.40 per cent.; nickel 0.26 per cent.; gold, none, and platinum, none.

[1] Survey and Exploration of Northern Ontario, Department of Crown Lands, Ontario, 1900, p. 149.
[2] Assay by W. K. McNeill.
[3] Assay by W. K. McNeill.

The rocks on Little Pine lake are almost horizontal, and are similar to those on Pine lake, namely, Laurentian (?), hornblende-chlorite gneiss. These are cut by massive, flesh-coloured biotite granite. No mineral deposits of any value were seen on the lake. Little Pine river, the outlet, flows with a swift current through an excellent agricultural area.

Economic Notes

No minerals in economic quantities have been found in the area, yet one would infer from the geology and mineralogy that certain localities are favourable for gold, molybdenite, iron pyrites and probably for iron and silver.

Gold.—In the Kowkash and Tashota area there are several gold prospects which are described by the writer in the report on that area. The Wells property near Tashota is the one on which most work has been done. Here a shaft 140

Fig. 10—Workings on pyrrhotite deposits, mining claim T B 2390, Pine lake, June, 1917.

feet deep and some lateral work on the 90-foot level show that there is an auriferous quartz deposit reported to average $5.00 in gold to the ton across five feet. Apart from the Kowkash-Tashota area which has been prospected only in a few parts, there is an unexplored area of similar rocks, extending at least from Caribou to Round lake, which might be worthy of prospecting for gold. Samples yielding 40 cents and 80 cents of gold per ton were obtained from veins on Caribou and Fuchsite lakes. In the vicinity of the latter lake the rocks consist of green schists intruded by numerous quartz porphyry dikes, an assemblage of rocks in which gold-bearing veins are frequently found.

Molybdenite.—The presence of molybdenite in granite and pegmatite on Tunnel and Tamarack lakes and in float on Trout lake, shows that molybdenite occurs over a wide area, and warrants a further search for the mineral in the vicinity.

Iron Pyrites.—Several deposits of iron pyrites occur in the Kowkash-Tashota area which would justify further exploration. Most of these deposits are described

in the report on the Kowkash area, the more important locations being marked on the map accompanying that report. On account of the present scarcity of sulphur the iron pyrites might be used in the making of sulphite pulp at the pulp-mills in northern Ontario. Deposits of little or no importance were seen on an island in Lone Breast bay, Smooth Rock lake, on Fletcher and Michell lakes, and with the iron formation at Round lake.

Iron.—Two iron ranges occur in the area, viz.: the Onaman range, consisting of a north and a south band in the vicinity of Paska station, and the Round lake range, which extends intermittently in a westerly direction to Caribou lake. The Onaman range, apparently the richer of the two, has on the whole too much rock interbanded with the narrow magnetite layers to make the deposits of economic importance; however, E. S. Moore who examined the deposits in detail in 1907 [1] and 1908 [2] regards the eastern end of the southern range, which lies two and three-quarters miles south of Paska station, to be worthy of further prospecting.

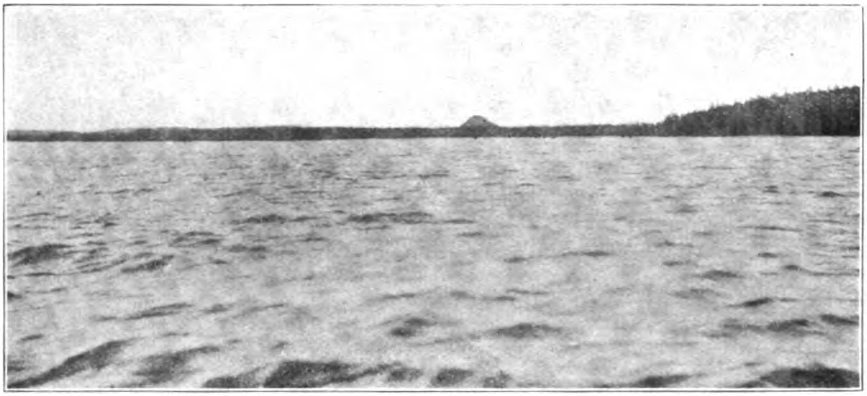

Photo by E. S. Moore.

Fig. 11—"Haystack" mountain, N. shore of Lake Nipigon.

Silver.—Silver was obtained in only one sample in the area, viz.: on the McKinnon claim which lies one and three-quarter miles north of Tashota. On this claim there is a large quartz vein, 25 feet wide in places, which contains a dark streak a few inches wide, rich in galena, zinc blende and chalcopyrite. Samples of the sulphides from this vein gave on analysis $1.00 of gold and 11 ounces of silver per ton. Numerous narrow calcite veins were seen cutting the diabase sill on McLaurin lake, to the southwest of Armstrong, but no silver values were obtained in the several samples which were assayed. Several calcite veins up to one foot in width occur in the Keewatin, which is capped by conglomerate and sandstone, and in turn by diabase, in the vicinity of Moon and Reef lakes. No silver values were obtained from these veins, but one would infer from the geology that such calcite veins are worthy of further investigation.

[1] Ont. Bur. Mines Report, Vol. XVII, 1908, pp. 170-189.
[2] Idem, Vol. XVIII, 1909, pp. 196-253.

NOTES ON LAKE ABITIBI AREA

By Percy E. Hopkins

Introduction

During September and part of October, 1917, a part of the Lake Abitibi Area was explored. This included a geological examination of a large portion of the shores and many islands of the Abitibi lakes. Examinations were also made of part of the Ghost river and a recent gold discovery in Rickard township. In addition, a track survey was made of the Okikodosik and Patten[1] rivers, and a trip made over a trail 15 miles north of Hughes station where silver was reported to have been found. Sketch maps of the various parts examined are embodied in the report. These were drawn by P. A. Jackson. The analyses of samples collected were made by W. K. McNeill, Provincial Assayer.

Fig. 1—Lifting pound nets, Lower Abitibi lake, September, 1917.

Only cursory examinations of the Abitibi area had been made by various explorers previous to M. B. Baker's[2] more detailed examination in 1908. Since that time the area has been made easily accessible by the construction of the National Transcontinental railway which touches the northern part of Lower Abitibi lake in places, and crosses several streams flowing into Upper Abitibi lake. Low Bush and Mace stations are within a few hundred feet of the lower lake, while La Reine and La Sarre stations in Quebec are on the Okikodosik and Whitefish rivers, 5 and 8 miles respectively from the upper lake. The excellent transportation facilities afforded by the railway and large waterways have attracted tourists and greatly aided the farming, fishing and pulp industries of the area. The Abitibi Pulp and Power Company are obtaining large quantities of pulpwood

[1] The name "Patten river," approved by the Geographic Board of Canada, has been substituted for that of "Woman river," there being several rivers in Ontario to which the name Woman has been given.

[2] Ont. Bur. Mines Report, Vol. XVIII, Pt. 1, pp. 263-283.

from their limits around the lakes. Owing to the lands not having been opened for settlement, no farming is being carried on at present in this part of Ontario, but on the Quebec side numerous farms have been located and large clearings made in the vicinity of the railway. A fishing industry has been established, the fish consisting of whitefish, pickerel, pike and suckers. Prospecting is hindered in part of the area by the scarcity of rock outcrops, but gold discoveries were made in 1917 in Rickard township, and also near the source of the Lightning river.

Topography

The country as a whole is low, flat and largely drift-covered, being part of what is generally known as the Great Clay belt. The long railway tangents suggest that the country is level and free from much rock. No rock was seen

Fig. 2—Hudson's Bay Company post, Upper Abitibi lake, Quebec, established in 1755. The two buildings in the foreground, over 50 years old, have been flooded recently by the raising of the level of Abitibi lake. The new buildings are in the background.

along the railway from Cochrane easterly to the crossing of the Low Bush river, a distance of 42 miles. The roughest part of the area is immediately south of Upper Abitibi lake, where numerous hills rise 300 to 600 feet above the lake.

Lake Abitibi, consisting of Upper and Lower lakes connected by a narrow channel, is a large but shallow lake, with an area of 350 square miles and a watershed of 3,735 square miles. The lake level was raised in 1913 by the building of a temporary regulating dam at Couchiching falls on the Abitibi river, five miles from the lake, by the Abitibi Pulp and Power Company. At this dam and at Low Bush water gauges are read daily, the datum being that of the National Transcontinental railway. The company endeavours to maintain a normal high water level not exceeding an altitude of 878.5 feet. For the year 1917, however, the average level of the lake equalled the above figure, due to the excessive precipitation during the months of June, July and August. Wind tides also have a very perceptible effect in changing the elevation at different parts of the lake.

There is a projected development by the Abitibi Company of Twin Falls on the Abitibi river, the power house to have four units operating under a head of 55 feet and using 4,500 cubic feet per second. This development will maintain the river above the dam at lake level and drown out Couchiching Falls entirely. Construction work was suspended temporarily early in 1917, the foundations of the dam being well under way at the time. At present the company derives power from Iroquois Falls, farther down the river. Twin Falls will supplement this.

General Geology

The geology of the area has been described by Mr. Baker; hence only a brief summary and a few additional notes will be given. The accompanying sketch maps (figures 8 and 9) serve to show the actual rock outcrops in certain areas.

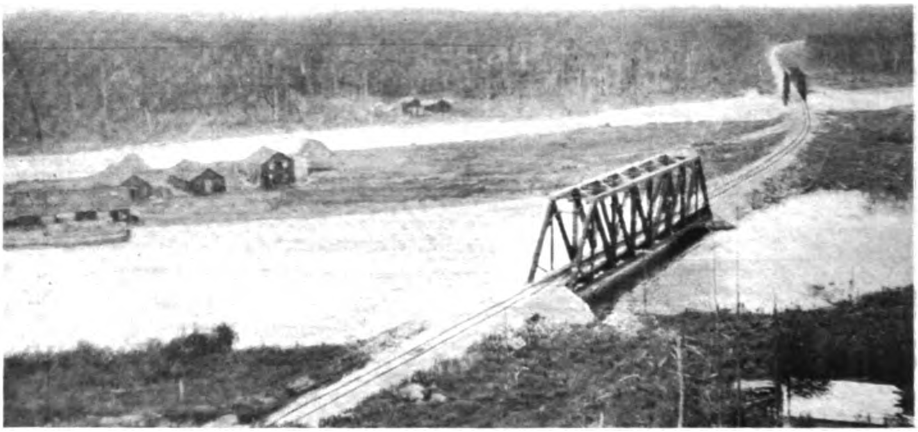

Fig. 3—National Transcontinental railway crossing of the Lowbush and Circle rivers, September, 1917.

Keewatin

The Keewatin consists dominantly of pillow lava and altered diabase, with subordinate amounts of agglomerate, conglomerate (?), slate, Iron formation, dolomite, and hornblende and chlorite schist.[1] The large volume of these volcanic rocks is a striking feature of the south shore of Upper Abitibi lake. Despite glaciation, the surface is rough and much broken, from the uneven weathering of the rocks, due to their ellipsoidal structure and the abundance of calcite. The principal area of slate and greywacké lies in the vicinity of Mace station. These fine-grained grey rocks may be composed partly of volcanic fragmental material which has been water-sorted. They strike about N. 80° E. and dip vertically, and may be continuous with the sediments on the west shore of the lake.

[1] These rocks are called Abitibi Volcanics by M. E. Wilson. Geol. Surv. Can., Mem. No. 39, Kewagama Lake Map-Area.

Intrusives

These older rocks are intruded by serpentine, granite, and diabase, the latter two being described by Baker as Laurentian and post-Middle Huronian, respectively. Their ages have not been definitely determined, since sediments of Timiskaming age have not been found in association with them.

On the east shore of Lower Abitibi lake is a massive dike-like mass of serpentine or altered peridotite clearly cutting Keewatin graphitic schists. A definite age has not been established. However, the serpentine resembles some of the serpentine deposits of the Porcupine area and those in Dundonald and Reaume townships, which are considered to be pre-Algoman in age.

Much of the quartz diabase and gabbro of the area appears to be younger than the Keewatin in the field, and yet has a slightly older look than the Nipissing diabase at Cobalt, and may also be pre-Algoman in age. Such rocks may be seen on the Ghost hills, (fig. 8), south of Upper Abitibi lake, in the new township of Lamplugh, and also on the Okikodosik and Patten rivers. Microscopic examination of these rocks confirms the field evidence. A sample from a point on the west shore of Upper Abitibi lake and one and a half miles south of the narrows, shows the feldspars altered to kaolin and sericite, and the augite to hornblende and chlorite, there being many graphic intergrowths of quartz and altered feldspars. Gold-bearing quartz veins are reported to occur in the altered quartz gabbro near the mouth of Patten river, (fig. 9). This rock resembles the diabase-gabbro intrusions of Robb township,[1] and Beatty and Munro townships,[2] where gold is also found. The diabase on Shaft or Gold island in Lower Abitibi lake contains a quartz vein carrying visible gold, and may be of pre-Algoman age also.[3]

The hornblende and biotite granites and syenites occur as batholiths, stocks and dike-like masses. The rocks are usually quite massive and fresh, thus resembling Algoman granites in other areas. The fact that gold occurs in a pegmatitic vein on lot 4, concession C, Steele township, and in a quartz vein cutting the granite in South bay, Lower Abitibi lake (see fig. 9), suggests that some of the gold deposits of Lake Abitibi are genetically connected with the granites.

Many of the quartz diabases cut the rocks described above and resemble, both megascopically and microscopically, the quartz diabases of the Cobalt area. Even if some of the diabases are Keweenawan in age, it will be difficult to separate them from the pre-Algoman (?) diabases. Silver appears to have accompanied the diabase intrusion at one place, viz.: north of Hughes station, to which further reference is made below. Should the Shaft or Gold island gold deposit belong to the Keweenawan epoch, then this is another example of gold deposition in the latter. The only other known similar gold-bearing deposits in Ontario which have been assigned to this age are those at the Crystal gold mine on Wanapitei lake and the Havilah mine north of Thessalon.[4]

[1] Ont. Bur. Mines Report, Vol. XXIV, Pt. 3, 1915, pp. 58-60.
[2] Ont. Bur. Mines Report, Vol. XXIV, Pt. 1, 1915, p. 180.
[3] Ont. Bur. Mines Report, Vol. XXIV, Pt. 1, 1915, pp. 243-248.
[4] Geol. Surv. of Can., Memoir No. 95, pp. 114-116.

Fig. 4—Collection of moose antlers by Indians, north of Ghost river, Abitibi lake. The large set has a spread of over five feet.

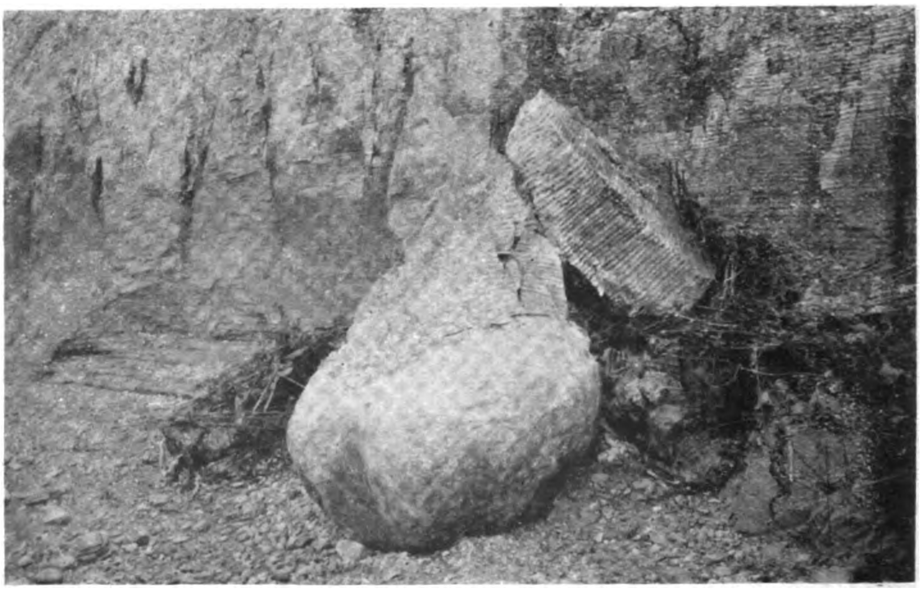

Fig. 5—Rounded greenstone boulder in stratified clay at cabin near mouth of Mattawasagi (Teddy Bear) river, Upper Abitibi lake, September, 1917.

Pleistocene

The drift deposits consist largely of stratified clay or clay and sand, which were deposited in a huge glacial lake named Lake Ojibway by A. P. Coleman. A beautiful section of the stratified clay, 15 feet thick, may be seen at the Indian cabin near the mouth of Teddy Bear or Mattawasagi river, township of Stoughton, (fig. 8). There are from 10 to 15 double layers in a foot-section of the clay. Near the bottom of the section the layers are slightly wrinkled and contain an occasional large, smooth boulder, probably representing glacial till. The rocks which rise through the clay have been glaciated, the striæ striking from 10° to 20° to the east or west of south, astronomic.

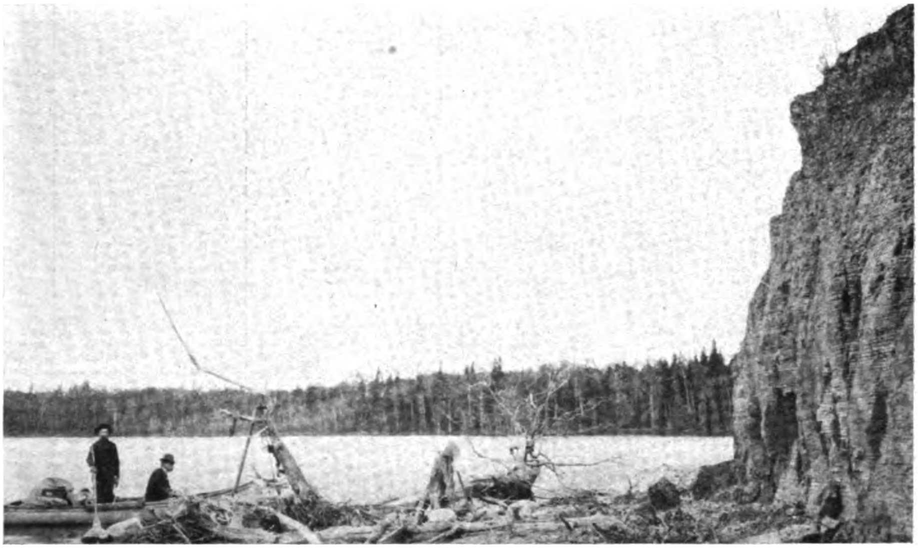

Fig. 6—Stratified clay at Indian cabin, near mouth of Mattawasagi (Teddy Bear) river, Upper Abitibi lake, September, 1917.

Economic Geology

Chromiferous Serpentine

On the east shore of Lower Abitibi lake, on lots 3 and 4, concession C, Steele township, is an occurrence of chromiferous serpentine which was discovered in 1909 by M. B. Baker. Mr. Baker was unaware of the presence of chromium until a laboratory examination was made of the serpentine collected. Since he did not return to the area, and owing to the importance of chromium in the steel-making industry in the form of chrome-steel for guns, armour-plate and tool-steel, it seemed advisable that a further examination should be made of the occurrence.

The massive serpentine, or altered peridotite, occurs as a dike-like mass cutting Keewatin graphitic schists, and is classed as pre-Algoman in age since it resembles the pre-Algoman serpentine in other parts of northern Ontario. The rock outcrop is larger than stated by Baker, having an area of at least five acres. The serpentine contains much finely disseminated magnetite and minute veinlets

of the same mineral. The rock is cut by narrow calcite veins carrying some talc. No reddish-brown streak, suggesting the presence of chromite, could be obtained from the black mineral. Baker, who describes the petrography and chemistry of the serpentine, obtained 6.72 per cent. of Cr_2O_3. This percentage is rather high for the rock as a whole, since a composite sample consisting of numerous pieces of serpentine from various parts of the outcrop, yielded on analysis[1] 2.75 per cent. of Cr_2O_3 and no platinum. This percentage of chromium

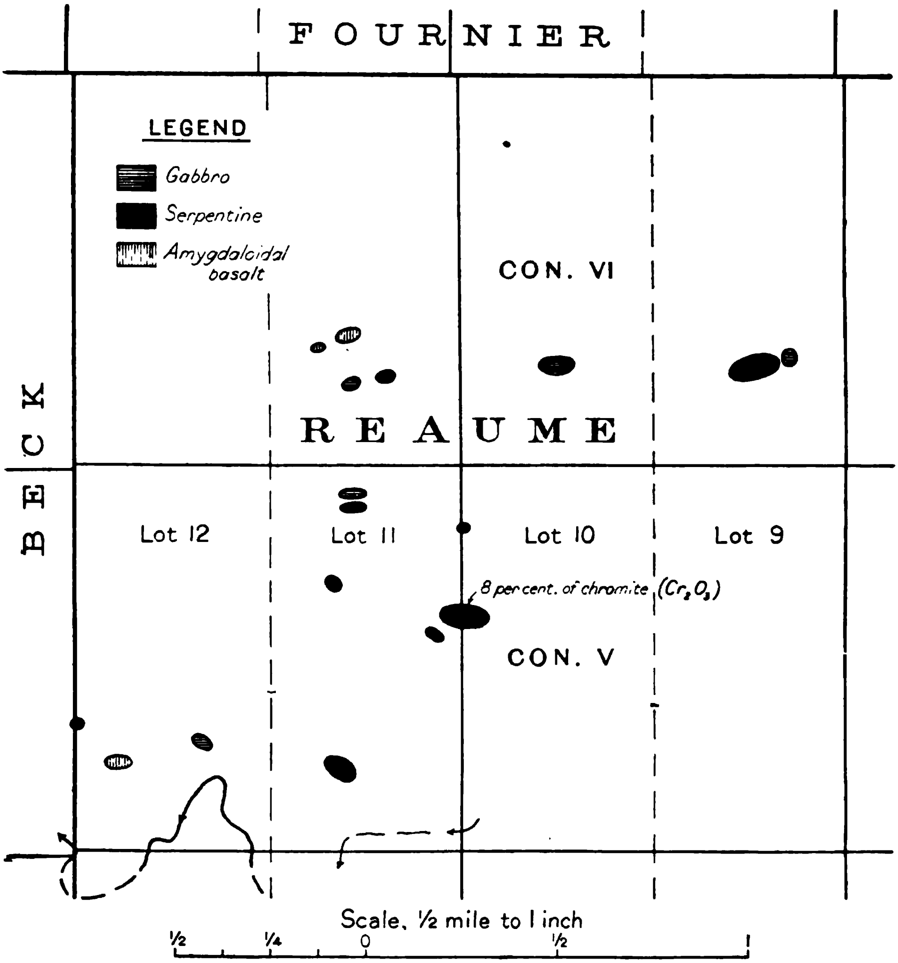

Fig. 7—Sketch map showing rock outcrops in the northwest portion of Reaume township.

is much too low to be of economic value. However, it might be advisable to trench along the borders of the serpentine mass in the hope of locating lenses of ore, as chromite often occurs at the contact.

Chromium was also detected in a sample of serpentine which was sent to the Bureau of Mines by William Campbell of Low Bush from a point on Lower Abitibi lake about four miles southeast of the outlet of Abitibi river. The sample

[1] Analysis by W. K. McNeill, Provincial Assayer.

resembled the serpentine previously described, and was found to contain[1] 0.82 per cent. of Cr_2O_3, no platinum and no nickel.

Serpentine occurs in various parts of northeastern Ontario,[2] some outcrops of which contain economic deposits of nickel-copper ore,[3] and asbestos,[4] while others contain chromium, platinum, and microscopic diamonds,[5] but not in commercial quantity. Certain of these outcrops are worthy of further prospecting for these minerals, especially for chromite, since practically all the chromite deposits of the world occur in serpentine and sands resulting from the disintegration of this rock. It is not likely that a large body of disintegrated serpentine will be found in Ontario owing to the country having been glaciated. Reaume township is one of the best known places in Ontario to prospect for chrome ore. The mineral occurrences have already been described; the accompanying sketch map, (fig. 7), may be of value to anyone wishing to prospect this locality. A small body of chromiferous serpentine carrying about 8 per cent. of Cr_2O_3 occurs on the line between lots 10 and 11, concession V, and approximately 33 chains south from the south boundary of concession VI, Reaume township. Much drift[6] occurs in the area, but by further trenching workable deposits of chromite might be found.

Early in 1918 D. O'Connor discovered chromite in the north part of lot 2, concession I, Dundonald township. The chromite occurs finely disseminated through serpentine. A sample assayed 1.34 per cent. of chromium.

The chief sources of chromite in the world and the most recent returns of production[7] are:—

	Year.	Production.
British Empire:		
India	1915	3,767 tons.
Rhodesia	1916	88,871 "
Canada[8]	1916	27,030 short tons.
Australia (N.S.W.)	1916	450 tons.
Other Countries:		
Asiatic Turkey	1909	11,364 metric tons.
New Caledonia	1916	74,115 " "
Bosnia-Herzegovina	1913	305 " "
Greece	1914	7,059 " "
Russia	1912	21,277 " "
United States	1916	40,000 tons (gross).
Japan	1911	1,527 metric tons.

The demand and prices for chromite have advanced in late years. The prevailing prices are very satisfactory, and in the latter part of 1916 the scale in force for Quebec chromite[9] f.o.b. Quebec Central Railway's stations was: 50

[1] Analysis by W. K. McNeill, Provincial Assayer.

[2] Some of these exposures are referred to by M. B. Baker, Ont. Bur. Mines Report, 1917, Vol. XXVI, pp. 270-2.

[3] Since 1912 the Alexo mine has been shipping ore which will average 4.90 per cent. of nickel and 0.60 per cent. of copper, according to the Report of the Royal Ontario Nickel Commission.

[4] During parts of 1916 and 1917 asbestos was shipped from the Porcupine area.—Ont. Bur. Mines Report, 1917, Vol. XXVI, pp. 108 and 273-4.

[5] Ont. Bur. Mines Report, 1914, Vol. XXIII, pp. 47-8.

[6] E. D. Bolton surveyed Reaume township in 1907 and reported seeing no rock in place; however, he remarked on the great irregularity in the magnetic variation of the compass, especially crossing lots 8 and 9, concessions V and VI.

[7] Department of Scientific and Industrial Research, Advisory Council, London, Eng., 1918.

[8] Canada's chrome ore comes from the Coleraine and Black Lake districts, Quebec, which produced 35,726 short tons, valued at $495,981 in 1917.

[9] Canadian Mining Journal, Mar. 15th, 1917, p. 121.

per cent. ore, $45 a ton; 40 per cent. ore, $38.75; 30 per cent. ore, $22.50; 25 per cent. ore, $18. For special purposes ore higher than 50 per cent. can be marketed at $1.00 a unit. Ore containing as low as 12 per cent. of Cr_2O_3 is being concentrated by two mills at Black Lake, Quebec.

In April, 1918, California chromite was offered at $1.40 to $1.60 per unit f.o.b. shipping points, this being for ore running 45 per cent. chromic oxide.

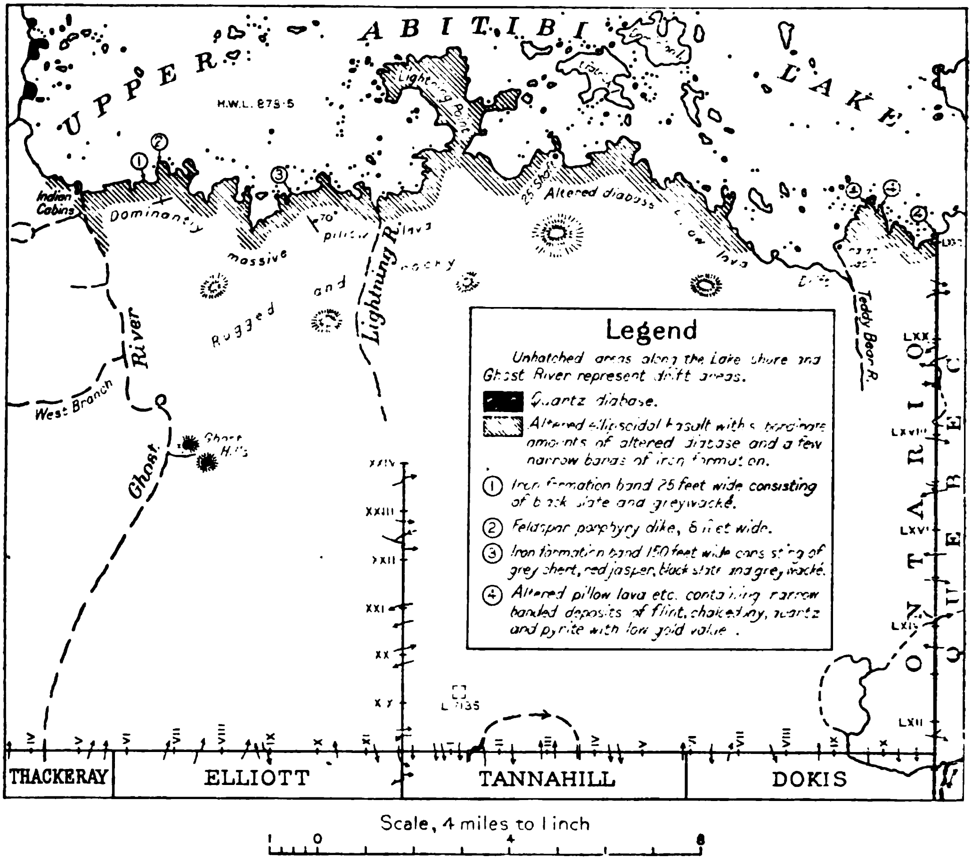

Fig. 8—Map of a portion of the south shore of Upper Lake Abitibi, showing approximate location of the original gold discovery claim, L 7135, north of the township of Tannahill.

Pyrite

On the southwestern edge of the serpentine mass referred to in lot 4, concession C, Steele township, is an iron pyrites deposit upon which some work has been done. The richest portion of the deposit is reported to be covered by water at present, Abitibi lake having been raised 9 feet by the building of a temporary dam at Couchiching falls. Mr. William Campbell, Low Bush P.O., Ont., who is a part owner, stated that the pyrites is practically pure over a width of 8 feet and for a considerable length. On the shore can be seen much gossan and considerable pyrite disseminated through a graphitic schist, the occurrences being almost identical with a pyrite deposit in lot 7, concession VI, McCart township.[1]

[1] Ont. Bur. Mines Report, 1917, Vol. XXVI, pp. 271-272.

Gold

On Abitibi Lake

During 1906 and 1907 numerous claims were staked for gold on the shore and islands of the Upper and Lower Abitibi lakes and considerable work done on some of them. The deposits are described by W. G. Miller[1] and M. B. Baker.[2] Four types of auriferous quartz veins may be mentioned, namely: (1) veins in the Keewatin greenstones; (2) veins in the Keewatin rusty-weathering dolomites; (3) veins in Algoman (?) granite, and (4) veins in quartz diabase, probably of pre-Algoman or Keweenawan age. The last type, which is the most promising, is represented by the Shaft or Gold island deposit (fig. 9). No work has been done on the property, however, since 1907, when a shaft 75 feet in depth was sunk on a narrow vein carrying considerable visible gold. The deposits on the shores of Upper Abitibi lake between Teddy Bear or Mattawasagi river and the interprovincial boundary (see fig. 8) are narrow, and consist of banded chert, chalcedony, red jasper and quartz, thus somewhat resembling a banded Iron formation. Much pyrite and some limonite are present, and low values in gold may be obtained on assaying.

On Patten River

In 1913 gold was reported to have been found at the 30-foot falls near the mouth of Patten[3] river which is about two miles west of mileage 126 on the interprovincial boundary. Several claims were staked and some surface prospecting done. The rock in the vicinity is an altered quartz gabbro, which looks fresher than the Keewatin and older than the Keweenawan. The quartz veins are narrow, usually under six inches in width, and contain pyrite, calcite and occasionally low gold values. The vein on the last portage at the 30-foot falls was reported to contain some visible gold. The deposits appear to be of no economic importance. However, they are of interest in that they represent another locality in Ontario where gold has been found.

The locality is reached from La Reine station, Quebec, by the Okikodosik and Patten rivers. A track survey was made of these waters by T. J. Patten, O.L.S., in 1906 in conjunction with his survey of the interprovincial boundary. The writer on his trip last autumn found only slight alterations were necessary in the plan of Patten's track survey, and has shown the rock outcrops on the accompanying map.

No pillow lavas were seen on the route; however, some of the hornblende and chlorite schist may represent altered volcanic flows, while others may be the basic parts of the Laurentian. Some of the granite gneisses appear to be typical Laurentian rocks, while the massive, fresh-looking granites resemble the Algoman granites.

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[1] Ont. Bur. Mines Report, 1907, Vol. XVI, pp. 219-220.
[2] Ont. Bur. Mines Report, 1909, Vol. XVIII, pp. 268-271.
[3] Previously known as Woman river.

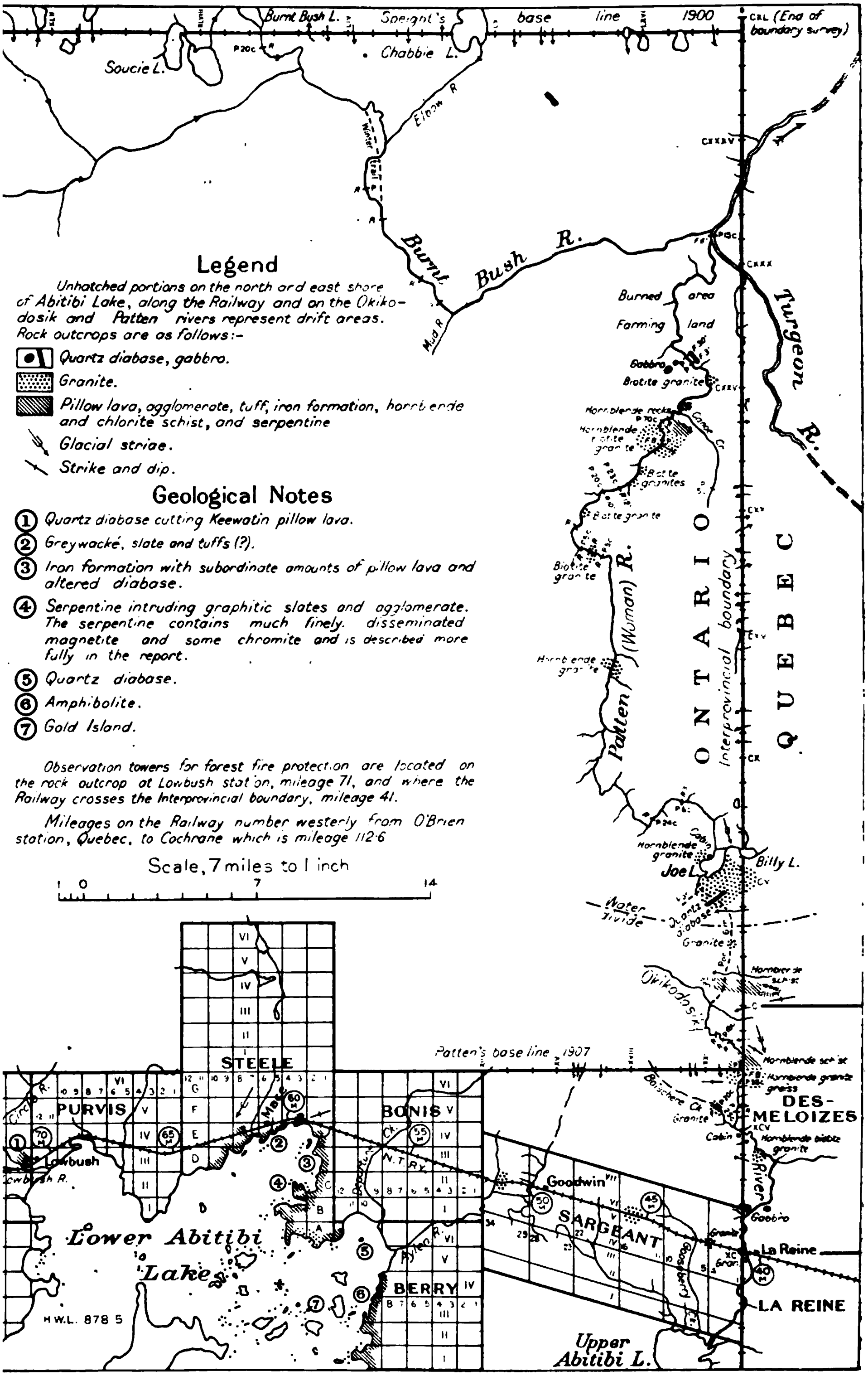


Fig. 9—Geological sketch map of part of the Abitibi Lake area.

In Rickard Township

Rickard township is situated 10 miles west of Abitibi lake and can be reached by the Abitibi river as shown on Fig. 10. The banks of the river from Abitibi lake to Couchiching falls, a distance of 5 miles, are low and free from rock exposures, but from Couchiching falls to Twin falls (which is situated to the west of Rickard township), a distance of 20 miles, the river has eroded the channel to a depth of 50 to 100 feet below the general land level, and occasionally rock outcrops may be seen. The rocks at Couchiching falls are pillow lavas intruded by numerous narrow quartz diabase dikes. One and one-half miles below, at Little Couchiching falls, in lot 2, concession IV, Knox township, is a greyish-green carbonate schist with large grains of quartz, representing probably an altered quartz porphyry. Seven or eight outcrops of altered ellipsoidal basalt may be seen between Little Couchiching and the west side of Rickard township. On account of the proposed development of Twin falls which will maintain the

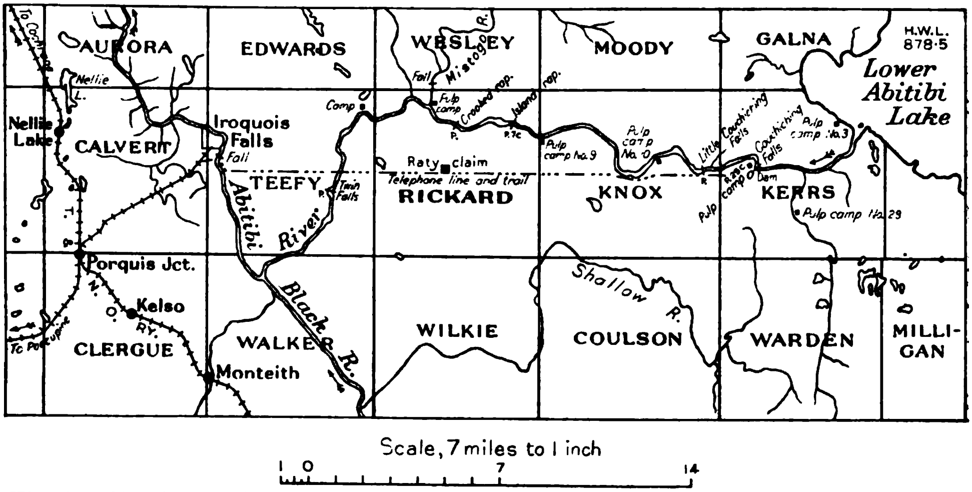


Fig. 10—Sketch map showing Rickard and other townships lying between the T. & N. O. Ry. and Lake Abitibi.

river above the dam at the level of Lake Abitibi, thus drowning out Couchiching falls, the timber along the river has been cleared away on each side, to make a wider water channel for the towing down of pulpwood. Much of Rickard township will be flooded, as shown by fig. 11.

In July, 1917, gold was found on the southwest quarter of the south half of lot 7, concession IV of the township. The discovery was made by a Finn named John Raty at a point 200 yards from a telephone line which runs from Iroquois falls to Couchiching falls on the Abitibi river and had been travelled for some years by the officials of the Abitibi Pulp and Power Company. Shortly after the discovery, representatives of two mining companies sampled the vein, but obtained low values. Later, in sinking, the prospector found a rich gold showing at a depth of five feet, which resulted in the Mining Corporation of Canada securing a working option. At present, April 1918, the shaft is 100 feet in depth at which level some drifting has been done. Some very rich samples have been obtained.

The country is undulating, and superficial deposits consist of stratified clay, through which occasional rocks rise as high as 100 feet above the stream valleys. Much of the forest in this area was destroyed by the big fire in 1916.

Only a cursory examination has been made by explorers of the geology along the canoe routes, with the exception of J. G. McMillan's exploratory trips across Rickard and surrounding townships in 1904.[1] The rocks are pre-Cambrian, consisting of Keewatin pillow-lava schist (meta-basalt), with subordinate areas of altered diabase and cherty Iron formation, all of which have been intruded by narrow dikes of feldspar porphyry and quartz-diabase, probably of Algoman

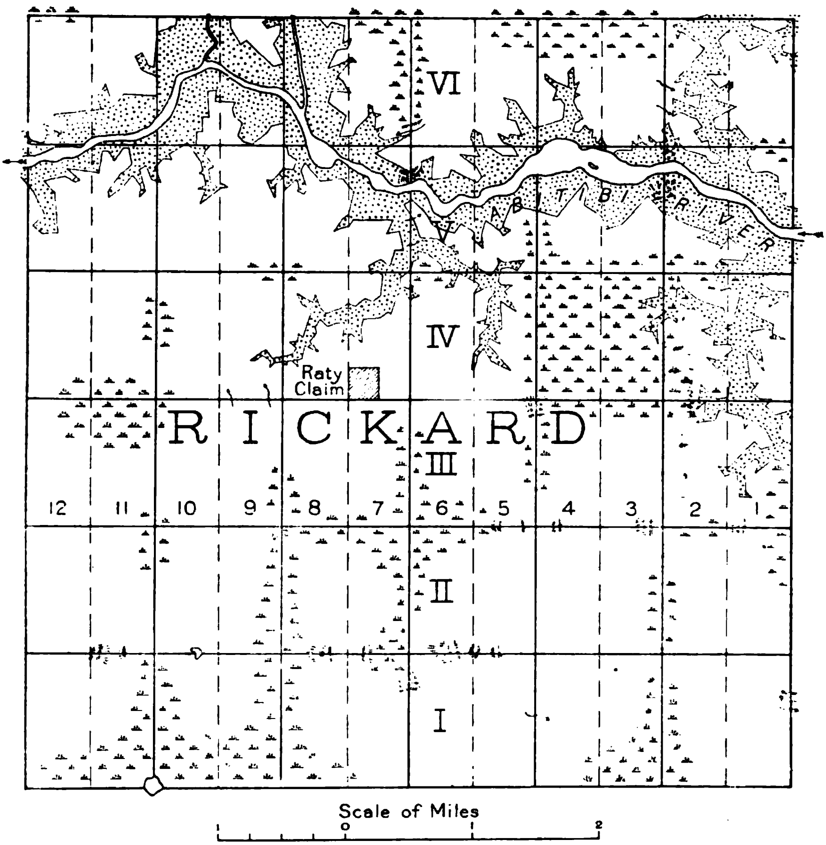


Fig. 11—Rickard township, showing location of the Raty gold discovery. The stippled area will be flooded as a result of the power development at Twin Falls.

and Keweenawan age respectively. The greenstones are in places altered to carbonate schists. The quartz-diabase appears to be similar, both megascopically and microscopically, to the Nipissing diabase at Cobalt, but its age cannot be definitely stated. A few narrow dikes of porphyry from two to ten feet in width intrude the greenstones on the Raty claim. About one-half the rock is composed of somewhat rounded phenocrysts of pinkish feldspars with some hornblende and quartz. Under the microscope many of the feldspars are seen to have a zonal struc-

[1] Ont. Bur. Mines Report, 1905, Vol. XIV, pp. 184-212.

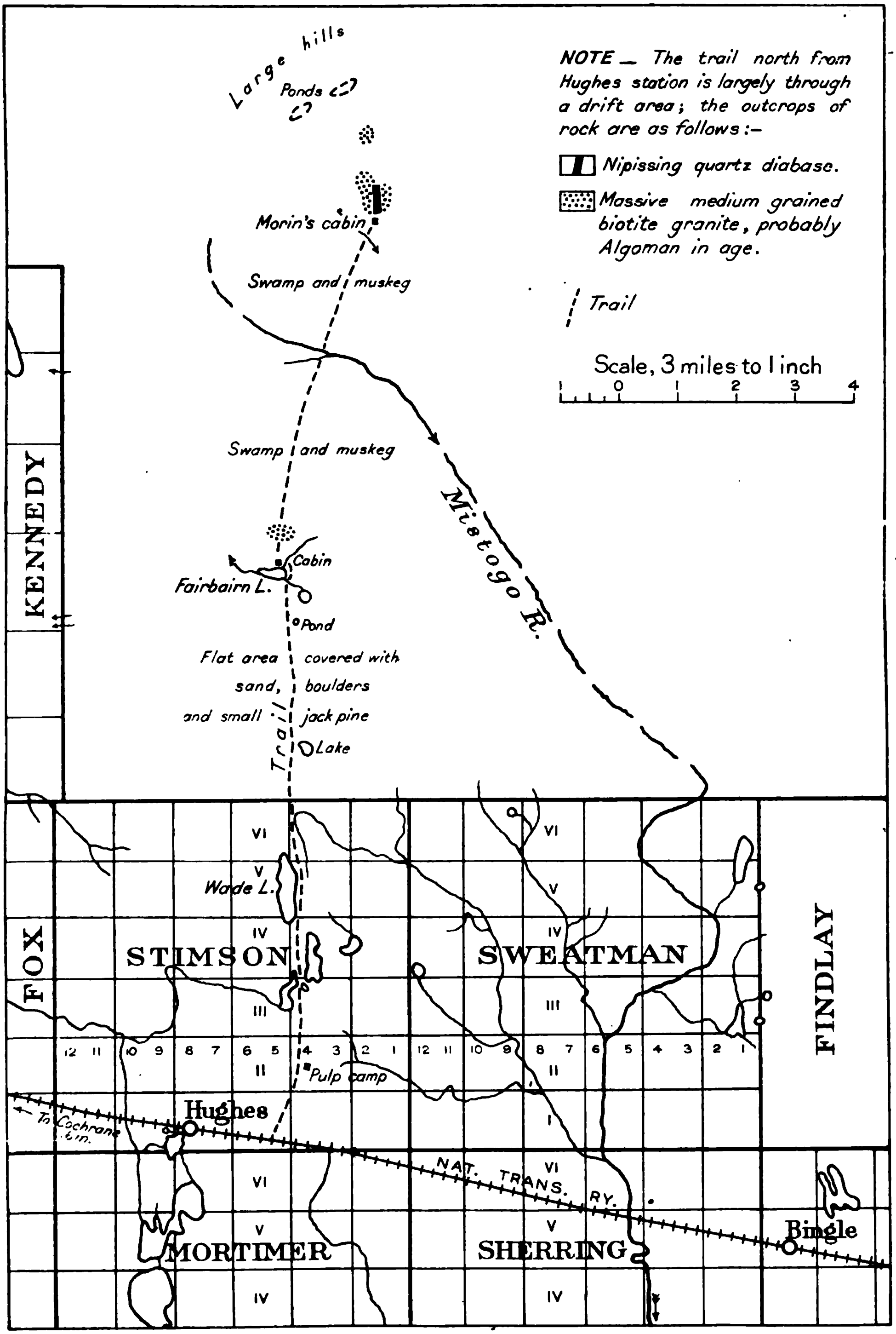


Fig. 12—Sketch map of a portion of the unsurveyed area north of Hughes Station, N. T. C. Ry.

ture, there being an occasional albite phenocryst. The hornblende phenocrysts are partly altered to chlorite. The groundmass is microcrystalline, and consists of hornblende, chlorite, plagioclase feldspar, quartz and apatite.

Gold was first found near the centre of the claim in a three-inch quartz vein striking east and west in a rusty weathered carbonate schist. The main deposit, however, is on the north part of the claim, and strikes east and west for at least 600 feet. The vein averages about six feet in width and dips almost vertically. Quartz, the chief gangue mineral, has a milky appearance. Calcite occurs as a replacement mineral in the wall rock rather than in the vein itself. Talc and sericite are frequently met with, while feldspar is not so prominent. Next to quartz pyrite is the most abundant vein mineral, there being also small quantities of copper pyrites, galena, and molybdenite. Molybdic oxide and native copper are secondary minerals near the surface. The gold, which is extremely coarse in places and varies in colour from light to dark yellow, occurs in crushed dark portions of the quartz with tellurides and other minerals, the gold usually crystallizing out after the tellurides. In the samples examined two tellurides have been identified, viz.: tetradymite (bismuth telluride) and altaite (lead telluride). A silver telluride may be present, as considerable silver was found on analysis. The values disappeared at a vertical depth of 40 feet. The magmatic waters connected with the porphyry intrusions may have had much to do with the ore deposition. The wall rock of the main vein is now a carbonate schist originating probably from a diabase. A small steam plant is in operation and diamond-drilling is being done.

Near Lightning River

A gold find was made by L. B. Howey, M. R. Howey, and W. M. Cochenour south of the Lightning river in the autumn of 1917, which resulted in a considerable number of mining claims being staked. The discovery claim, L. 7135, in the recently-named township of Holloway, which is shown in fig. 8, lies approximately one and three-quarter miles northeast of the northeast corner of Elliot township. Messrs. G. Young and S. Cragg, who have optioned the claim, state that gold values up to $10 to the ton were obtained from samples, and that the vein is about one foot in width, 200 feet long and dips about 25° from the horizontal.

Silver

A trip was made from Hughes station, N. T. C. railway, into the unsurveyed territory 16 miles to the north, where silver was reported to have been found by J. Morin. The trail is over sand plains, swamp and muskeg as shown on fig. 12. On the trail to the north of Fairbairn lake is a small outcrop of massive, pink, medium-grained, biotite granite. Similar rock occurs on Morin's claim, which in addition is cut by a quartz-diabase dike, 60 feet wide and probably of Keweenawan age. In the diabase and running in the direction of the dike for about 200 feet, is a quartz-calcite vein from a few inches to one foot in width, which contains small quantities of chlorite, pyrite, galena and copper pyrites. A few samples from the vein yielded on assay 3 ounces of silver to the ton and no gold.

THE MATACHEWAN GOLD AREA

By A. G. Burrows

Introduction

In the fall of 1916 a discovery of gold was made on the Davidson claims in Powell township, which is on the Montreal river, in the District of Timiskaming. Powell township is near Fort Matachewan, a Hudson's Bay Company post, consequently the area has become known as the "Matachewan Gold Area." Prospecting had been carried on from time to time since the discovery, in 1906, of silver in James township, at Elk Lake. Gold was found at several places in the southeast part of Alma township and in the north central part of Cairo township, in an area of syenite, a few years previous to the discovery in Powell.

At the Davidson claims in Powell township the original discovery was native gold in an irregular mass of quartz and rusty weathered schist. In 1917 gold was

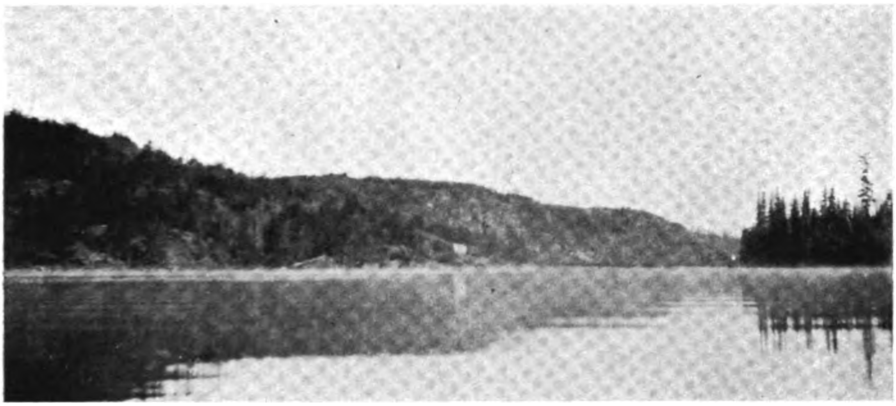


Fig. 1.—Scene on the Montreal river, north of the mouth of the East Branch (looking north).

found in a reddish porphyry by Sam Otisse on his own claims to the northeast of the Davidson. This prospector also discovered gold in a band of grey pyritous schist which lies to the south of the porphyry. Further work on the Davidson claims resulted in gold being found in the red porphyry which outcrops on these claims.

Since there was no detailed geological map of this area, the writer was instructed by Dr. W. G. Miller, Provincial Geologist, to make an examination of the country in the vicinity of the "finds." It was found that while a number of claims had been staked the previous winter, work was being done on only a few of these, consequently only a very small part of the new staking has been well prospected.

A geological knowledge of the area was obtained by travelling the township boundaries, traversing most of the water routes, and making sections away from

the water routes. Only a few of the claim lines in the vicinity of the Davidson find were travelled, since most of the claims were very irregularly staked in the winter and difficult to follow in the thick bush in summer. However, a general examination was made of Powell, Cairo, Baden and Alma and the Matachewan Indian Reserve, while portions of the north parts of Yarrow and Kimberley also received attention.

During the season of 1917, Dr. H. C. Cooke, of the Dominion Geological Survey, examined an extensive area to the west of the Matachewan area, and his map of this country, showing the geology and canoe routes, will be of great assistance to the prospectors working westerly from the Montreal river.

Fig. 2.—Davidson camp. The discoverer of gold on the Davidson, Jake Davidson, is the second figure from the left.

Ingress to the Area

The nearest railway station is Elk Lake, the terminus of a branch line of the Timiskaming and Northern Ontario railway that leaves the main line at Earlton station.

From Elk Lake there is a canoe route up the Montreal river a distance of about 30 miles to the Davidson landing. In high water in spring a gasoline boat has been utilized as far as the foot of the Long portage, with a short portage around Indian Chute. The trip by canoe alone is very arduous, owing to the swift current in the Montreal river above Indian Chute. In this trip three portages are necessary. In low water during the summer all the stiff rapids above Indian Chute are usually poled or tracked.

A route from Elk lake, by way of Long Point lake, was used by various parties in 1917. This requires transportation of supplies and canoes over the Gowganda wagon road to Long Point lake, from which there is a water route down stream by way of the East Branch of the Montreal river to the Matachewan area. Supplies for operations in 1918 were taken in (from Elk Lake railway station) over a winter road that roughly follows the Montreal river.

Early References to the Area

In 1875 Robt. Bell, of the Canadian Geological Survey, made an exploration survey of a route from Lake Huron to James Bay.[1] In his report he describes the east and west branches of the Montreal river, which flow through the Matachewan area. The geology is of necessity very briefly described, but reference is made to the conglomerate and other rocks along the route. The igneous rocks are for the most part called diorite, a general term for the basalt, diabases and other rocks in the complex of basic igneous rocks. Bell describes a quartz vein containing specular iron ore, along the east branch, about ten miles south of the junction with the main Montreal river.

In the Report of Survey and Exploration of Northern Ontario, 1900, J. L. R. Parsons,[2] geologist with Exploration Survey Party No. 3, gives a brief description of the geology along the Montreal river where it traverses the Matachewan area. He obtained low values in gold from two samples of quartz and pyrite in veins near the first rapid below Fort Matachewan.

In 1903 G. F. Kay made an examination of an area to the southwest of Lake Abitibi. His report has a description of a canoe route from the Black river to Fort Matachewan. Part of this route is shown in the northeast portion of the accompanying geological map of the Matachewan gold area. Microscopical descriptions of rocks occurring on Turtle, Separation and other lakes in the Indian Reserve or in Alma township, are given in Mr. Kay's report.[3]

In 1911, the Bureau of Mines, Ontario, published a sketch map, by W. M. Goodwin, showing part of the geology of the area between Porcupine and Gowganda. On this map the geology of part of the west portions of Powell and Baden townships is given.

In 1914, P. E. Hopkins, of the staff of the Bureau of Mines, examined claims in Yarrow township, on which iron ore was reported, and also some fluorite and barite veins in Cairo township. His notes on these occurrences are referred to later in the report.

Topography

The country described in the report is near the height of land separating the waters flowing to James Bay from those flowing to the St. Lawrence river. A portage at the north end of Matachewan lake crosses the divide between these waters. The area is of the rocky lake type, but much of the rock is concealed by a

[1] Geological Survey of Canada, 1875-6; Report of an Exploration in 1875 between James Bay and Lakes Superior and Huron, p. 301.

[2] Report of Survey and Exploration of Northern Ontario, p. 111.

[3] The Abitibi Region. Ont. Bur. Min., 1904, Vol. XIII, p. 112.

thin covering of soil. Where not recently burned over, there is a very heavy growth of medium sized timber. The topography is quite rugged in parts, some hills reaching 200 feet above the plain. Changes of elevation of 50 to 100 feet are frequent. Conspicuous hills can be observed near the north end of Matachewan lake. These are of greyish andesitic rock intruded by fresh-looking diabase. On the west side of Mistinigon lake there are high ridges of quartzite and conglomerate of the Cobalt series. Matachewan lake from its north end to Fort Matachewan is simply a long narrow sheet of water with precipitous shores on either side. The portion of the Montreal river above the Long Rapids in Kimberley township consists of a series of lake expansions with high shores and connected by short flat rapids.

Fig. 3.—One of several large pot-holes at the mouth of Davidson creek.

An interesting feature relating to the physiographic history of the area has been the diversion of the west branch of the Montreal river from its former to its present course. At one time the river flowed easterly from a point one and a half miles north of the south boundary of Powell, through what are now the Davidson claims, and emptied into the Montreal river a mile north of the junction with the East branch. The ancient channel followed for three-quarters of the distance the course of Davidson creek shown on the map. From a small pond at the end of the small stream flowing to Davidson creek there is a depression for three-quarters of a mile to the present West branch. The divide between this pond and the West branch is seventeen feet above the latter, in low water, as determined by Sutcliffe and Neelands in their hydro-electric survey of Matachewan or Big Bend falls. At

the west end of the pond there is a large dry pot-hole in the greywacké slate formation, and also a large cavern-like basin in the pond itself which had been formed by the cutting action of a strong eddy in the old river. For a half mile along Davidson creek, near Davidson camp, there is an accumulation of huge boulders along the bed of the old stream, while near Davidson's landing, at the mouth of the creek, there are numerous large pot-holes in the Keewatin rocks. Some of these pot-holes are shown in the accompanying illustrations. The West branch empties into Lake Matachewan at Matachewan falls, where there is a drop of 41 feet in 600 feet. The diversion of the river from its former course has been quite recent, geologically speaking, since the falls have been carried back only a short distance from the lake, with practically no gorge. There are two small rapids above the falls and below Mistinigon lake, and it is probable that formerly this

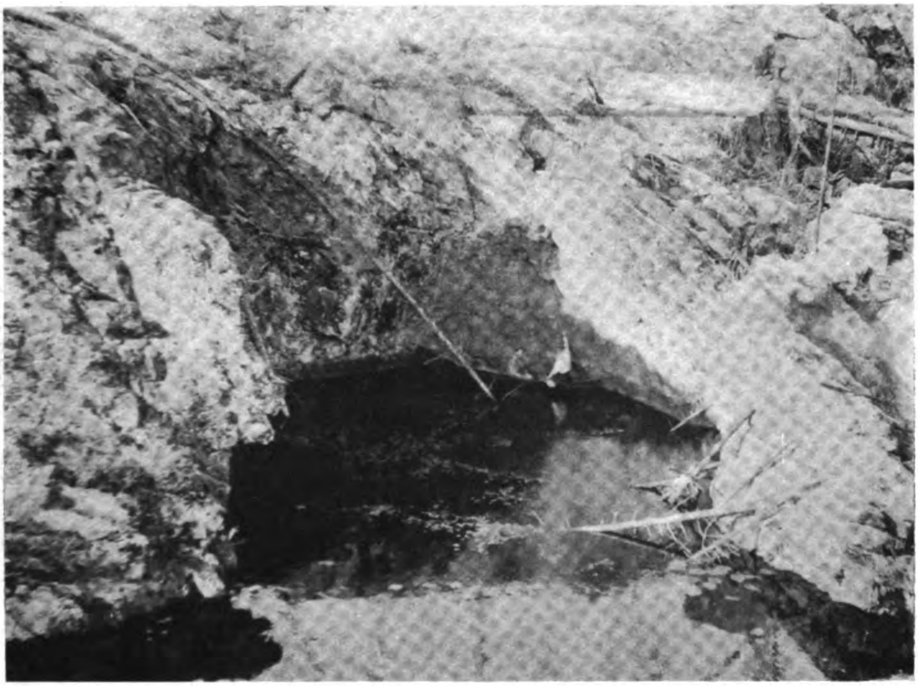


Fig. 4.—Cavern-like basin at the head of the north branch of Davidson creek. At one time this was probably part of the old course of the west branch of the Montreal river.

lake was a long narrow body of water closed at its north end, and discharging easterly from opposite the big island.

The old course of the West branch followed a depression between the older Keewatin series and the later sedimentary rocks of the Cobalt series, as shown on the accompanying geological map.

Timber

This area has been burned over several times in the history of the Hudson's Bay Company at Fort Matachewan. Charred stubs of large pine trees are frequently observed throughout the green forest. The present timber is suitable for

pulpwood, railway ties and local building purposes. It consists of the common trees of northern Ontario, spruce, jackpine, balsam, birch, poplar and cedar. Along the east shore of the Montreal river, from the East branch to the north end of Matachewan lake, there are small groves of red and white pine, which represent the northerly limit in northern Ontario for these trees.

The greater part of Cairo township has been burned over recently, exposing rolling sand plains and areas of rocky ridges burned off clean. A stretch across the southerly part of Powell township was burned over in 1916.

Fig 5.—Fort Matachewan. Steve Lafricain, for many years in charge of the Hudson's Bay Co. post at Fort Matachewan, is the second figure from the left.

Agriculture

The area is not suitable for agricultural purposes, except in small patches. Most of the soil is gravelly and sandy, and there are wide stretches of clean sand with small jackpine. Small areas have been cleared by the Indians in the Indian Reserve, and there is a vegetable garden at Fort Matachewan. Fine potatoes, turnips and cabbages are grown at these places.

Geology

The compact rocks are all referred to the pre-Cambrian. The following legend shows a classification of the rocks in the probable order of geological succession, from the Pleistocene to the Keewatin.

PLEISTOCENE—
GLACIAL AND RECENT ....Sand and gravel.

PRE-CAMBRIAN—
ANIMIKIAN (Cobalt series) ...Conglomerate, quartzite, slate-like greywacké.

(*Unconformity*)

ALGOMAN? ....Granite, syenite, porphyry, diorite, diabase.

(*Intrusive contact*)

LAURENTIAN? ....Granite, gneiss.

(*Intrusive contact*)

KEEWATIN ....Greenstone (pillow lava), meta-basalt, andesite, old diabases, serpentine, felsite, volcanic fragmental, Iron formation, conglomerate.

INTRUSIVE ROCKS ....Diabase.

The oldest rocks of the area are of Keewatin age and consist mostly of basic to intermediate volcanics, accompanied by chert (Iron formation) and schistose sedimentary rocks like quartzite and conglomerate. These have been intruded by numerous diabase and porphyrytic dikes, whose age, beyond that they are younger than the Keewatin schists, is difficult to determine.

The older rocks have also been intruded by acid rocks like granite, syenite, gneiss and porphyry, which are probably of Laurentian or Algoman age. These acid rocks have also been intruded by numerous dikes of diabase, some quite fresh-looking.

A series of flat-lying sediments of the Cobalt series has been deposited on the eroded surface of the older greenstones, granites, syenite, porphyry, and some of the diabase dikes.

At only one place was a diabase dike observed intruding the Cobalt series, but a few others have been reported. This is in marked contrast to the older rocks, which are everywhere intruded by numerous dikes of diabase, consequently most of these dikes would appear to be older than the Cobalt series. In addition, at several points unconformities between the Cobalt series of sediments and diabase dikes have been noted. It would therefore seem that the conglomerate in the area would not be worth prospecting for silver, owing to the scarcity of sills and dikes of diabase of Keweenawan age.

Keewatin

The Keewatin is represented by altered lavas, meta-basalt, andesite, porphyry, diabase, serpentine, carbonate rocks, Iron formation, quartzite, conglomerate, etc. These rocks are for the greater part much altered, and many are now schists. Where schistose the general strike is approximately northeast and southwest.

Both amygdaloidal and ellipsoidal lavas occur in parts of the area, but most of the greenstone type of rock is fine-grained, dark-coloured meta-basalt. Fine-grained blackish rock can be well observed in the Keewatin area east of Whiskey Jack creek, in Cairo township. Here the ferromagnesian mineral has been altered to chlorite, but laths of plagioclase are well preserved, with extension angles near oligoclase-andesine. Secondary feldspar, mica and quartz are present, also numerous grains of magnetite, altering to leucoxene.

Excellent exposures of pillow lava occur to the south of St. Paul lake and on mining claim HF 13, west of Fox rapids. In the latter place there are also numerous amygdules in the altered lava. The pillow lava, east of the road from Fox rapids, is associated with bands of volcanic fragmental, of fine-grained and agglomeratic character, and some cherty Iron formation.

Light coloured felsite occurs with the pillow lava and Iron formation on claims HF 13 and 12502, west of Fox rapids. In hand specimens the rock is quite fine-grained, but under the microscope occasional small phenocrysts of feldspar are seen. The rock is crushed, and contains numerous minute veinlets of secondary quartz. The siliceous iron formation is in bands, and several pits have been sunk on it where there is an oxidized surface from the weathering of iron pyrites. These different rocks are intruded by dikes of diabase, and thin remnants of basal conglomerate of the Cobalt series overlie unconformably this complex.

Rocks north of Davidson Creek.—The Keewatin rocks in Powell township that are exposed to the north of Davidson creek are greatly altered to schists. Some of the green and grey schists are probably derived from igneous rocks of basic to intermediate composition. Other schists are highly oxidized at the surface and show no indication of their origin. While rusty-weathering, below this oxidation they are light grey in colour, and contain quartz, carbonate, sericite and iron pyrites. On the Otisse claims, 5379 and 5380, this grey rock has been found to be gold-bearing, and it may prove of economic value as a gold deposit.

On mining claims 5387 and 5390, and adjacent claims, extremely altered volcanic rocks, some of which are fragmental, are recognized. They are cut by numerous whitish-weathering feldspar-porphyry dikes and diabase. The older rocks and the porphyry dikes contain quartz veinlets in places, and low values in gold are sometimes obtained. One of the porphyry dikes occurs on the trail 30 chains west of the Montreal river; another on the creek south of a small lake on claim 5402. A greyish porphyry dike with quartz veinlets is seen 12 chains northwest of number two post of claim 5385. These dikes belong to an older series than the orthoclase porphyry on the Davidson and Otisse claims, and are probably associated with the Keewatin rocks. Similar dikes occur in other parts of the area, but they do not appear to be of economic importance.

Sedimentary Rocks.—Schistose sedimentary rocks are seen on the east shore of Mistinigon lake about one and a half miles north of the south boundary of Powell and on the north side of the trail leading to the Davidson claims. The rocks are in vertical attitude and strike N. 60° E. They can be traced easterly in the township to beyond Otisse lake, and consist of coarse material resembling conglomerate, and finer material like greywacké. The inclusions in the conglomerate rock are mostly small fragments of rocks of obscure origin, whitish porphyry, felsite, etc. A sample of the greywacké material from 15 chains north of No. 1 post, claim 5375. examined in thin section, contains numerous fragments of feldspar and quartz and bits of rocks, in a fine groundmass. This rock is best preserved on the north shore of Otisse lake. Small porphyry dikes, altered dikes of basic igneous rock, and numerous diabase dikes, interrupt the continuity of these bands across country. No

relationship was observed between these schistose sedimentary rocks and the schistose altered igneous rocks to the south, consequently it is thought advisable to group them with the Keewatin, of which they appear to form a part.

However, the possibility of these sediments being a remnant of the Timiskaming series, folded with the Keewatin, must be considered. This area lies midway between Midlothian township, where J. G. McMillan[1] recognized a wide area of Timiskaming, and the Kirkland Lake area, where this series occurs in large volume.

Light-coloured Porphyritic Rocks.—There are a number of light grey-coloured porphyritic rocks which are associated with the dark, very basic Keewatin greenstones, that are also probably altered volcanics, since these occur in larger volume than is generally seen in the porphyritic dikes. These rocks are prevalent in parts of the Indian reserve, especially on Turtle lake, and around Matachewan lake above Matachewan falls. Feldspar phenocrysts can often be observed in hand specimens. A sample from the east expansion of Turtle lake shows altered plagioclase phenocrysts, in a groundmass of hornblende needles, biotite, zoisite, feldspar, and quartz. There are also rounded areas of fine-grained secondary quartz. Some of the rock is crushed and mashed to resemble a conglomerate, but is an autoclastic. Volcanic fragmental material occurs on the north line of Alma township to the west of the two-mile post, and on part of the shores of Alma lake. Along with the altered igneous rock in the northeast part of Alma there are bands of slate-like rock, greatly metamorphosed, and belonging to the Keewatin complex. Owing to the intermingling of the sedimentary with the igneous metamorphosed rocks, it would be difficult to separate them.

To the south of the narrows at the south end of the upper part of Lake Matachewan there is a greyish porphyritic rock, which under the microscope proves to be an andesite or porphyrite. Phenocrysts of plagioclase (oligoclase or andesine) and hornblende (actinolite) are abundant, while these are surrounded by small rods of feldspar in a dense groundmass in which hornblende can be recognized. Rocks of somewhat similar appearance occur on both sides of the lake inland, so that the volcanic rock is widespread and is probably an old lava flow rather than an intrusive.

An analysis of the grey porphyritic rock by W. K. McNeill, Provincial Assayer, shows the following percentage composition: Silica 59.06, alumina 14.39, ferrous oxide 5.80, ferric oxide, 2.14, lime 6.98, magnesia 5.11, soda 2.75, potash 1.20, water 2.31, carbon dioxide 0.44.

Serpentine.—There is an exposure of serpentine on a small island near the west shore of Mistinigon lake, one-half mile north of Bell island. The rock contains minute veinlets of asbestos. Serpentine also occurs at points on the east shore where there is a large proportion of carbonate, the surface of the rock being altered to a rusty brown colour. The rock also contains a number of white calcite veins.

[1] T. & N. O. Railway map of part of area between Gowganda and Porcupine, 1911.

One mile northeast of Fox rapids, there is a mass of serpentine on the west side of Whiskey Jack creek. Here a pit has been sunk, but no asbestos or chrome ore was observed in the material on the dump. Just south of the pit there is a mixture of serpentine and carbonate rock in bands that are much contorted, with a rough honeycombed surface where the lime rock has been leached out.

Diabase in Keewatin.—In the areas of Keewatin, particularly in Powell and Baden townships, there is an abundance of diabase with the older rocks. This diabase has not been separated on the map from the older rocks. The occurrence is similar to that in other Keewatin areas, as in Maisonville and Munro townships, where diabase occurs in large volume with the greenstones and other rocks. The age of this diabase is unknown, but its freshness under the microscope suggests that it is much younger than the greatly altered Keewatin. Since the Timiskaming series in neighbouring areas, *e.g.*, Kirkland Lake area, is also schistose like the Keewatin, it is probable that the diabase is also younger than this series and consequently post-Timiskaming.

A specimen of quartz diabase from a ridge just south of the 2nd mile post on the north boundary of Powell township is quite fresh under the microscope. It contains laths of plagioclase and augite, some of the latter showing twinning. Quartz is present in numerous grains; a small quantity of magnetite occurs in the specimen.

Granite and Gneiss (Laurentian?)

There are exposures of granite and gneiss along the Montreal river from a short distance below Fox rapids to the foot of the Long Portage. Similar rocks occur along the north boundary of Kimberley between the crossings of the Montreal river. The two rocks, reddish granite and dark grey to black glistening hornblende gneiss, are intermingled, and are similar to rocks that in areas farther south have been referred to the Laurentian.

Granite and Diorite (Algoman?)

There are two small areas of reddish hornblende granite in the north part of Powell township. There is another small area in the northwest part of Baden township, and a larger area of granite and quartz diorite in the northeast part of Baden and the northwest part of the Indian reserve. The granite is pinkish in colour, and the diorite is a grey coarse-grained rock in which the feldspars are mostly plagioclase, the other constituents being orthoclase, quartz, hornblende and biotite.

Very small outcrops of granite occur in the northeast part of Alma township. The exact age of these isolated areas of granite is not known. They are all quite fresh and massive, and intrude the Keewatin. They are probably of Algoman age, like similar rocks in the Kirkland lake and Cobalt areas, that are younger than rocks of the Timiskaming series.

Syenite (Algoman?)

There is a batholith of syenite which extends across parts of Cairo and Alma townships into Holmes and Flavelle townships to the east. It has a width across

Cairo and Alma of five miles. Here and there it is intruded by fine-grained reddish acid dikes and also by dikes of diabase.

The rock is generally of a rich red colour in fresh material, and varies greatly in crystallization, often showing lathlike porphyritic crystals of feldspar one-half an inch in length. There is usually only a very small percentage of hornblende and quartz in the rock.

A specimen from the Brookbank claim, in the southeast part of Alma, is a quartz hornblende syenite, composed largely of red feldspar showing a somewhat perthitic intergrowth in the crystals. Magnetite and apatite are accessory minerals.

A specimen from the Chief claim, also in the southeast part of Alma, is similar in its feldspar, but contains only a little chlorite as the ferromagnesian mineral.

A sample of syenite from the Biederman claim (16042) on Browning lake was analyzed by W. K. McNeill for its alkali content and contains 9.05 per cent. of potash and 2.95 per cent. of soda, showing that most of the feldspar is orthoclase. The high percentage of potash in the syenite is worthy of note, being about three-quarters as much as that contained in the orthoclase feldspar at the well-known Richardson feldspar mine in Frontenac county, on which experimental work has been done for the production of soluble alkalies, in aid of the fertilizer industry. It may be that at some future time this large deposit of syenite will be of value as a source of potash.

The syenite is an important formation, since several gold-bearing veins have been located in it, and while no economic deposits are yet proven, the area is worthy of careful prospecting. In the same rock veins of barite and fluorite have also been discovered.

The syenite is intrusive into the Keewatin, but underlies unconformably the conglomerate of the Cobalt series.

The erosion of the syenite batholith took place largely before the deposition of the rocks of the Cobalt series, since a considerable area of conglomerate lies unconformably on the syenite in Cairo township.

Relationship Between Syenite and Granite-Gneiss.—The relationship of the syenite to the granite and gneiss in the southeast part of Cairo is not known, but the syenite is believed to be the younger rock, since it shows no gneissic structures, and is probably of Algoman age. There are a number of syenites, granites and porphyries in northern Ontario with which gold-bearing quartz veins are associated, and these are considered to be post-Timiskaming intrusives, following the irruption of which there was gold mineralization.

Orthoclase Porphyry (Algoman)

Intruding the schist, on the Davidson, Otisse, and other claims to the north-east, there is a reddish porphyritic rock, that outcrops at various points. Owing to the great amount of drift and the intrusion of diabase dikes it was not determined whether the porphyry occurs as an irregular dike or as a series of stock-like bodies. On the Davidson claims, numbers 5372 and 5374, the porphyry is very irregular, as determined by trenching, and has a somewhat oval shape, with greatest

width of about 300 feet. On the line between the northeast Davidson claim (5375) and the Otisse claim (5379), the porphyry has a width of at least 450 feet, and is probably even wider, since the rocks are drift-covered to the south.

In most of the rock phenocrysts of feldspar can be observed. Under the microscope these prove to be orthoclase. The groundmass is largely feldspar of similar composition. Chlorite is present in small amount. Crystals of iron pyrites are abundant in the rock, and in surface specimens are partly altered to limonite. In addition there are quartz and calcite veinlets and replacements of the same minerals.

On the surface the rock is partly oxidized and discoloured by iron oxide stain. In one trench on the Davidson an excavation over six feet in depth was made with pick and shovel in loose rock. The weathering has also broken down large domelike masses of porphyry into loose fragments, as seen in the illustration.

There are numerous quartz veinlets in the mass of porphyry. These are seldom over three inches in width, and most of them are fractions of an inch. These

Fig. 6.—A hummock of orthoclase porphyry, weathering to small fragments, on Davidson claim 5372.

irregular veinlets give the porphyry the character of a stockwork. Samples of porphyry with quartz are occasionally encountered on the surface, showing visible gold, and the decomposed earthy surface will usually show gold in panning.

At the west end of the outcrop on the Davidson, near the contact, the porphyry contains quite large crystals of orthoclase, nearly an inch in length, and a similar rock is seen in a dike of porphyry extending northwesterly on the Robb claim, 5399. Any extension of similar porphyritic rocks to the west is concealed by a thick covering of conglomerate of the Cobalt series.

An analysis of the orthoclase porphyry, by W. K. McNeill, Provincial Assayer, shows the following percentage composition: Silica 61.80, alumina 18.86, ferric

oxide 2.95, ferrous oxide 0.32, lime 0.63, magnesia 0.34, potash 8.86, soda 3.19, water 0.54, carbon dioxide 0.84, pyrite 1.45; total 99.78.

The small stock-like masses of orthoclase porphyry on the Davidson and Otisse claims are probably of the same relative age as the syenite of Cairo township.

The high percentages of potash in the two rocks suggest a similar origin, while the different crystallization expressed may be due to the relative size of the intrusive bodies.

Cobalt Series

In the southerly part of the area covered by the accompanying map there is a wide extent of rocks of the Cobalt series, consisting of conglomerate, quartzite and slate-like greywacké, similar to other numerous exposures over a wide extent of

Fig. 7.—Conglomerate hill (Cobalt series) west of Davidson discovery.

country from Cobalt northwesterly to Porcupine, and named by W. G. Miller from the occurrence of these rocks with the silver deposits at Cobalt.

The series is generally in a nearly horizontal attitude of gently undulating rolls, seldom with greater dip than twenty degrees. Along the south boundary of Powell the sediments dip gently to the east at 5° to 15°. East of Davidson creek a section shows in ascending order quartzite, slate, conglomerate, quartzite, greywacké and conglomerate. Twenty chains east of the southwest corner of Powell township a cliff facing west exposes 18 feet of reddish weathering greywacké, overlain by 12 feet of conglomerate, with southeasterly dip of 5 to 10 degrees.

However, along the north shore of the main Montreal river, one and one-half miles west of Fox rapids, the rocks of the Cobalt series, quartzite and conglomerate,

are more highly tilted, to nearly 45 degrees. This may be due to a fault along this part of the river, which shows such a marked dissimilarity between the rocks on the different sides. A conglomerate just west of the mouth of the creek flowing from Knott lake has been rendered somewhat schistose, but contains the usual large fragments of Algoman (?) granite and syenite.

Unconformity at Base of Cobalt Series.—Basal conglomerate is exposed at numerous points extending from the West branch to near Fox rapids. One-quarter of a mile northwest of No. 1 post, claim 5374, there is a striking unconformity between the Cobalt series conglomerate and the Keewatin. Here the old surface

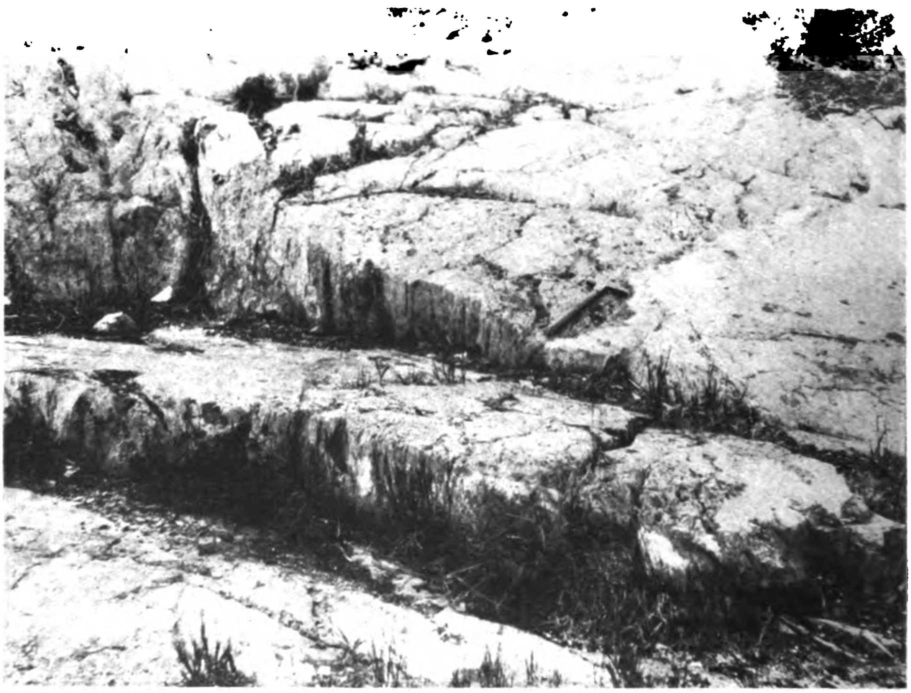


Fig. 8—Flat-lying sediments of Cobalt series in the east part of Yarrow township.

consisted of a banded schistose sediment which had been intruded by a diabase dike about 30 feet wide. Recent erosion has exposed these old rocks to about the original surface on which the Cobalt conglomerate was deposited, as there are thin skins of isolated patches of conglomerate at several places. This conglomerate contains large fragments of the old sediment and also of the diabase, and the line between the old schist and the later conglomerate is very distinct. The material here has been derived from local rock rather than by glacial transportation from a distance, but the old pre-Cobalt series surface, from the present evidence, would indicate a rather smooth rounded outline.

Other similar unconformities can be observed just west of No. 2 post, claim 5383, and on claim HF 13, west of Fox rapids.

On the northeast shore of Moyneur lake, in Cairo township, the conglomerate lies unconformably on the syenite. There is a similar relationship exposed in a cliff on the west side of the beaver meadow that extends southerly from Cameron lake. Here the conglomerate was deposited on a steep surface.

On the east shore of Mistinigon lake, opposite the north end of Bell island, there is a hill of conglomerate which overlies Keewatin. On the north side of the hill the Keewatin consists of chert or Iron formation, that extends along the shore for a quarter of a mile. Fragments of the chert are included in the base of the conglomerate.

Diabase

Diabase occurs abundantly in parts of the area. The Keewatin and the intrusives (granites, syenite and porphyry) are cut by numerous dikes of diabase;

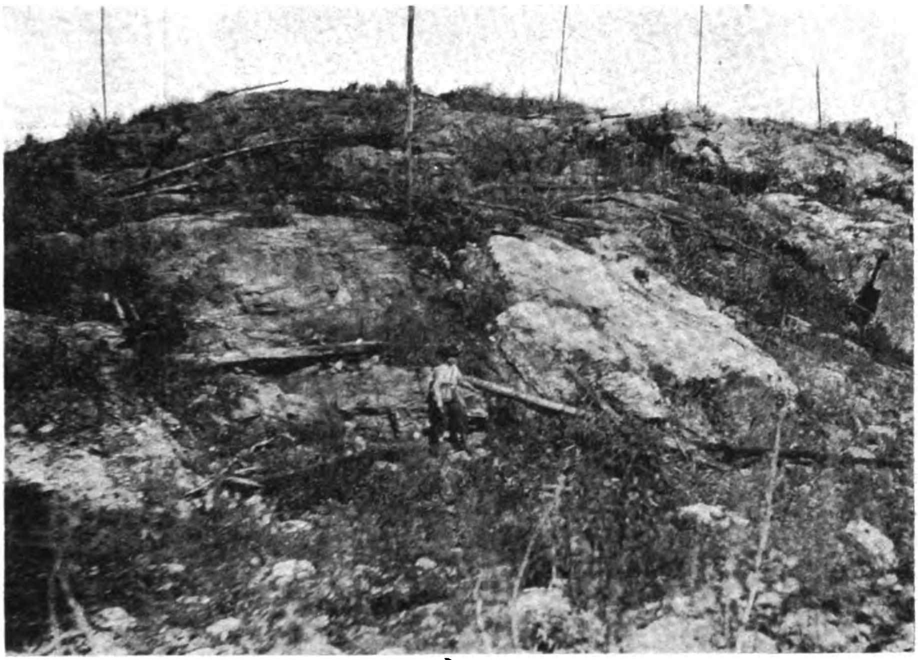


Fig. 9.—Unconformity, claim 5383, between conglomerate of Cobalt series (light-coloured patch), and underlying dark-coloured Keewatin, intruded by diabase.

whereas in the rocks of the Cobalt series these dikes are quite rare. In the vicinity of the Davidson claims there are several dikes of diabase that lie unconformably below the basal conglomerate of the Cobalt series. These dikes intrude the orthoclase porphyry that has been classed with the Algoman intrusives. It is probable that most of the dikes are post-Algoman and pre-Cobalt series in age.

The dikes ordinarily are of the normal type, medium-grained, showing chiefly plagioclase feldspar and augite with some interstitial quartz.

Occasionally porphyritic varieties that contain large phenocrysts of greenish feldspar up to two and three inches in diameter are observed. One of these occurs on

the north line of Alma, 20 chains west of the second mile post. It contains greenish porphyritic feldspar in a coarse matrix of labradorite and augite with magnetite.

There are several narrow dikes of porphyritic diabase intruding Keewatin rocks along the trail north of Davidson creek.

On the east shore of the southwest bay of Squaw lake in the Indian reserve there is a hornblende diabase. Small rods of plagioclase are set in crystals of hornblende and hypersthene. Interstitial quartz is abundant, and magnetite occurs in small grains.

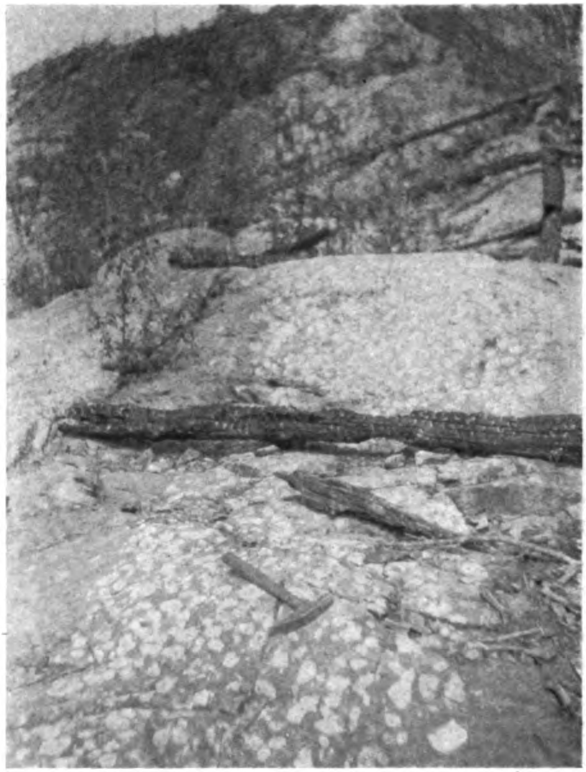


Fig. 10—Dike of porphyritic diabase on trail to Davidson camp from Montreal river.

Pleistocene

Deposits of unconsolidated material cover a great part of the area. These consist largely of sand and gravel accumulations of glacial origin. A wide stretch of sand and gravel in the form of a rolling plain occurs in the southeast part of Cairo and the northeast part of Kimberley. This plain is crossed by the Long portage. There is an esker-like ridge on the south boundary of Cairo, just west of Whiskey Jack creek. The Height of Land portage at the north end of Matachewan lake is over a sand plain, probably an outwash plain from a glacier.

Morainic ridges of boulders are seen two miles up the East branch of the Montreal river, and the trail from the Montreal river to the Davidson claims follows along a similar ridge.

Economic Geology

The chief interest in the area is in its possibilities as a gold producer. For some years gold has been known to occur in Cairo and Alma townships, but it was not until the discovery on the Davidson claim in Powell in 1916 that the area attracted much attention.

Since only a small part of the area has been closely examined by the prospectors, it is possible that other promising finds will be made in the Keewatin areas in Powell and adjoining townships. The Keewatin rocks near the contact with the intrusive syenite in Cairo and Alma townships should be worthy of close examination, and it is possible that other small masses of orthoclase porphyry, similar to the occurrences on the Davidson and Otisse, will be found. Prospecting is, however, rendered difficult by deposits of sand and gravel over much of the area.

Gold in Cairo and Alma Townships

Gold was found by Jake Davidson, a prospector, in the sand-gravel stretches to the north of the Montreal river, near Fox rapids; the writer is informed by him that he frequently obtained colours in the pan, but found no place where there was any placer workable under present conditions.

Gold occurs in quartz veins in some parts of Cairo and Alma townships.

Craig Claims.—The Craig claims are situated about three miles north of Fox rapids. Here a wide quartz vein was discovered with a north and south strike. At one place trenching has shown a width of 150 feet of quartz, and silicified and brecciated syenite which is the wall rock of the vein. Part of the vein material is somewhat felsitic in appearance, suggesting some fine-grained igneous rock related to the syenite.

At one point a shaft has been sunk about 60 feet, with short drifts on the vein, and fine visible gold has been reported in the shaft and drifts, and in samples on the dump. No gold, however, was seen by the writer, but samples of material from the dump showed low values in gold. A little iron pyrites was observed in pieces of quartz and syenite, but generally the sulphide is in very minor quantity. The property is equipped with a small steam hoisting plant and has a good set of mine buildings.

Chief Claim.—The Chief claim (17310) is situated about 20 chains west of the two-mile post on the east boundary of Alma. A discovery of gold in a small hummock of syenite, which outcrops in a beaver meadow, was made some years ago. The vein strikes E. and W. and is quite narrow, varying in width from a mere crack to about six inches where exposed for 30 feet. A few shallow pits were sunk on the vein, and some samples rich in gold are reported to have been taken from the westerly pit, which was filled with water at the time of the visit. A sample of vein material from the dump, consisting of quartz, chalcopyrite, and a little galena, gave an assay of $4.40 in gold. Attempts were made by trenching to pick up the vein on the hill to the east, but only mere stringers were found, a sample of which showed no gold.

Brookbank Claim.—This claim (17801) lies in the southeast corner of Alma township, where the rock is a red syenite. Some work has been done about four chains west of the east boundary of the township and just northeast of the cabin, which is on the boundary. Here there is a N.-S. vein on which two pits had been sunk. The vein is about two inches in width between the pits, showing for 30 feet. The vein filling is chiefly quartz, but contains also some galena, copper pyrites, pyrite, and some barite and fluorite. No gold was observed, but one assay of two inches of vein contained $5.20 in gold and 8 oz. in silver, while another of five inches in width from the north pit gave $7.60 in gold and 8 oz. in silver.

Cooper Claim.—Gold is also reported on the Cooper claim (MR 5645), which lies nearly a mile northwest of the Brookbank.

The above properties were not being worked during the summer of 1917, and there were only a few prospectors in Cairo and none in Alma.

Fig. 11.—Large boulders of auriferous quartz and schist, Davidson claim 5372.

Gold in Powell Township

Davidson Claims.—These claims are situated in Powell township about two miles west of the Montreal river. Gold was found by Jake Davidson in 1916, on the south part of claim 5372, in a mass of quartz and schist. This deposit strikes nearly east and west, and has been traced by trenching for 225 feet. It dips 60°S., is 40 feet wide at the west end, and narrows toward the east. The quartz is very irregularly distributed in the schist, and for the most part the veinlets or quartz masses are transverse to the strike. The deposit very probably is lenticular in form. To the southeast there are a number of huge boulders of material from this deposit. The surface of the schist is weathered to a brown

rust, largely due to the oxidation of the iron in the ankerite, which forms a part of the altered rock. There is also a proportion of bright green serpentinous mineral. Gold in a state of very fine division was noted at a few places in this deposit. The only sulphide observed is a little iron pyrites, but for the most part the deposit is deficient in mineralization. A few chains southeast there is a quartz vein on which a pit had been sunk some years previously by Steve Lafricain, of Fort Matachewan. This quartz vein contains small quantities of cobalt bloom, iron and copper pyrites, which first attracted attention, but promising values in gold or silver were not obtained on assay.

The Keewatin rocks accompanying these veins are quite schistose, igneous and sedimentary. To the north of the first mentioned deposit there is a whitish altered porphyry which shows phenocrysts of orthoclase and plagioclase in a groundmass

Fig. 12.—Auriferous quartz and schist deposit, Davidson claim 5372.

of feldspar and quartz, with much sericite and calcite. Near this altered porphyry there is ashy weathering chert, or Iron formation. Part of the south wall of the deposit is schistose quartz-porphyry with conspicuous phenocrysts of quartz.

Intruding the schist in the north parts of these claims there is a red orthoclase porphyry that has been referred to previously as gold-bearing. Iron pyrites occurs abundantly in portions of this rock, and there has been considerable oxidation, resulting in the breaking down to a red earthy material or loose fragments on the surface, that has involved a certain amount of surface concentration. This condition varies greatly in different parts of the property; on some of the knolls there are only a few inches or less of oxidized rock, but one trench shows over six feet of loose oxidized material. Consequently, for a proper examination of the deposit, it would be necessary to prospect below this shallow rusty surface by means of open cuts through the weathered rock, by drilling, or by shafts.

The porphyry is cut by numerous veinlets of quartz which in places carry visible gold, that frequently occurs near the contact with the porphyry and also in the wall rock, near the veinlets. In one deep trench there are several flat-lying quartz veins from a fraction of an inch to two inches in width. In other places the quartz veins may be irregular in their distribution, the whole mass occurring like a stockwork. It is quite likely the quartz veins are genetically connected with the porphyry, being the filling of tension cracks that have developed on the cooling of the rock, while the gold has accompanied the quartz in the formation of these veins. Sometimes gold can be observed deposited on grains of iron pyrites in the quartz or along the wall rock. A few samples were taken from the Davidson by the writer. One of these, from the surface of the porphyry in a trench on claim 5372, gave on assay $10.00 per ton over a length of 15 feet. The porphyry here was not so altered as is frequently seen, but visible gold was observed in minute quartz veinlets near the place from which the sample was taken.

Another surface sample from a long trench at the northeast corner of the claim gave on assay a value of $15.20 over a length of ten feet in the trench. Several specimen samples of quartz and porphyry carrying iron pyrites gave values of 80 cents to $2.00 per ton. None of these assays are quoted as representative of the actual value of the whole mass of the porphyry, but indicate its gold-bearing character. It may be found on extended examination that there are isolated parts of the porphyry which are sufficiently enriched with gold to be of economic value.

The following is a description of a microscopic examination of gold-bearing porphyry and quartz from Davidson claim 5372:

Orthoclase crystals are set in a groundmass of smaller feldspar crystals with a little chlorite in flakes and scattered crystals of apatite. Calcite is abundant as a secondary mineral. Quartz occurs in small secondary masses and in veinlets. Cubes and irregular grains of pyrite with an oxidized surface of limonite are frequent in the porphyry and also in the quartz veinlets. The quartz veinlets contain clear secondary feldspar, plagioclase and microcline moulded on the older feldspars of the porphyry. Vein calcite also accompanies the quartz in the veinlets, while native gold occurs near the wall rock in the quartz. A small amount of copper pyrites is occasionally seen. None of the rarer minerals, like the tellurides, have been recognized in any of the samples examined.

Otisse Claims (5379-5380).—These claims lie directly east of the Davidson group, and, owing to a somewhat deeper covering of drift and a smaller amount of trenching, the distribution of the rocks is not as well known.

In the northwest part of claim 5379 the orthoclase porphyry is well exposed. There is also a surface oxidation similar to the Davidson, with an amount of loose brown earthy material in which trenches were made. Gold has been found in a number of pits in the same association as in the porphyry on the Davidson.

To the east of this outcrop other occurrences of porphyry have been located by Sam Otisse in heavily timbered country; it is probable that a band of porphyry extends through the northerly part of the claims.

Near the centre line of the claims, a few chains north of the south line, there are outcrops of rusty weathered schist in which native gold has also been discovered.

This band of rock lies to the south of the porphyry band. Below the oxidized surface the rock is light grey in colour and spotted with pyrite. Examined under the microscope it contains much secondary silica, calcite, sericite, and iron pyrites, indicating that the rock has been entirely altered by replacement from its original composition. Mr. Otisse discovered gold at several other places on his claims in rocks which are of different character from those described above.

An examination of these properties in January last resulted in options being taken on these and adjoining claims, and it is expected that during the summer of 1918 a thorough examination will be made to prove their possibilities as gold producers.

Otisse Claim (5376).—This claim lies north of the Davidson claim, 5372. The rocks are largely schistose sedimentary rocks intruded by narrow porphyritic dikes. Six chains north of the Davidson claim there is a quartz vein striking nearly east and west, and three to four feet wide in places. It contains, in parts, copper pyrites, iron pyrites, and galena. Fragments of grey porphyry in the quartz suggest that the vein was formed along an old porphyry dike. Gold values are reported from this vein. A selected sample of quartz, galena, and copper pyrites contained $1.20 in gold per ton.

In the southwest part of the claim there is a narrow red porphyry dike that strikes northwesterly to the Robb claim. It contains quite large crystals of orthoclase, and is probably a narrow dike representative of the stock-like mass of red porphyry on the Davidson. Gold is reported to occur in this dike.

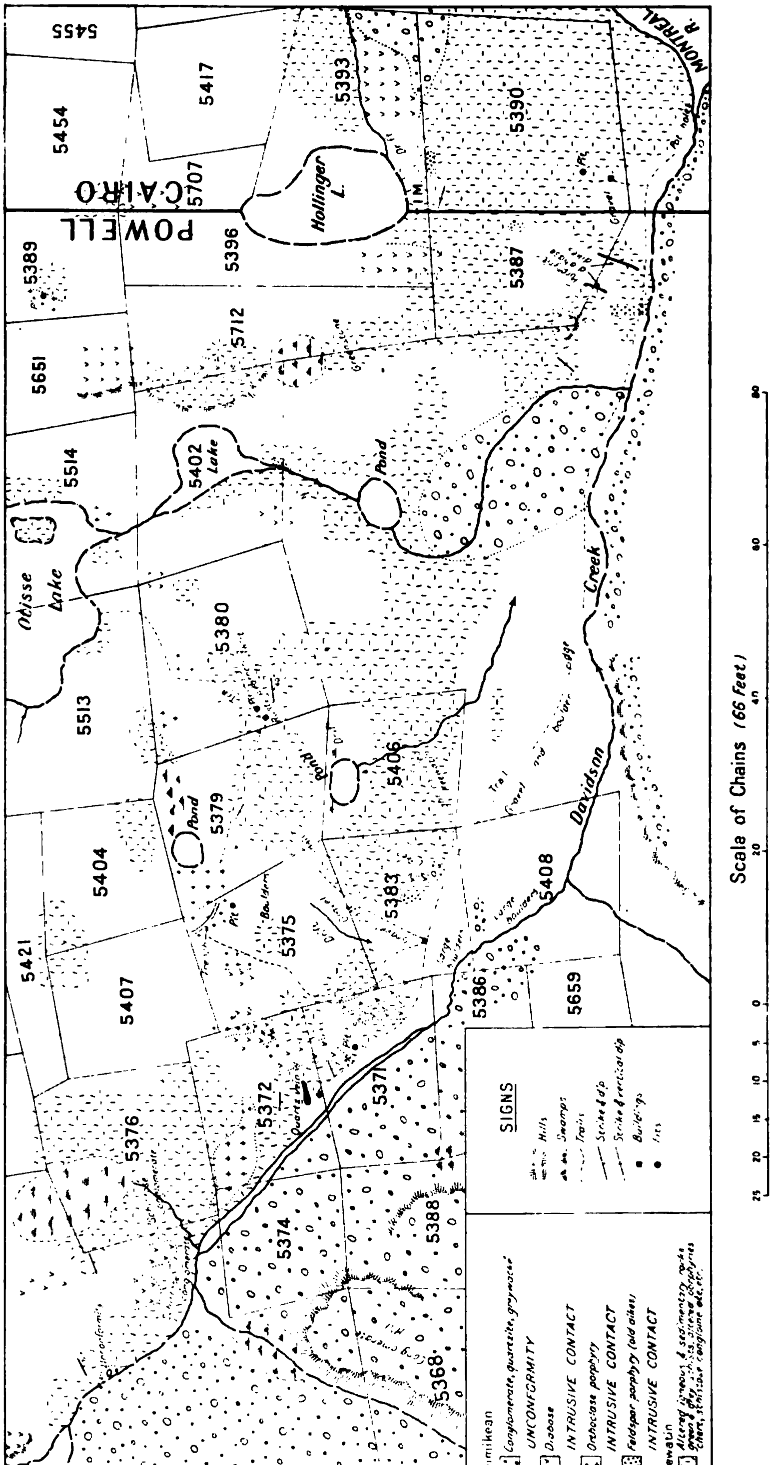
O'Connell Claims (5389-5390).—On claim 5389, adjoining the boundary line between Powell and Cairo, there is a reddish feldspar porphyry dike that intrudes a slate-like rock of Keewatin age. This porphyry is much harder than that on the Davidson and Otisse claims, and does not show so heavy a mineralization with iron pyrites. It is cut by quartz veinlets, and has been partly prospected by stripping and a shallow open cut. Low values in gold from this material are reported by the owners.

On claim 5390, one mile south, work was done on a band of blackish chert-like rock cut by quartz veinlets with pyrite, from which low gold values were also obtained.

Fluorite

Fluorite (fluorspar) has been found in small quantity in a number of quartz veins in Cairo and Alma townships, but none of the deposits examined are of commercial value. Owing to the widespread occurrence of the mineral, it is possible that prospecting might result in the finding of economic deposits. The mineral is of a deep purple colour, occurring in small masses in the quartz or in the wall rock adjacent to the veins. It is also present in the Biederman barite vein. One occurrence where the fluorite is in the quartz is on the Harvey claim, No. 18285, west of the road from Fox rapids north to the Craig claims. This vein is about seven inches wide, strikes N. 75° E., and has been traced several hundred feet. Some pieces of fluorite, two inches across, were taken from the vein. All the showings of fluorite are in the syenite.

GEOLOGICAL SKETCH MAP OF PARTS OF THE TOWNSHIPS OF POWELL AND CAIRO.



MINING CLAIMS

Connell—5513, 5514; Davidson—5371, 5372, 5374, 5375, 5383; O'Connell—5387, 5389, 5390, 5651; Otisse—5376, 5379, 5380; Robb—5402.

Barite

Veins containing barite occur in several parts of the area. These are generally small, but two deposits have been found which would be of commercial value were they nearer railway transportation. These are the Biederman deposit in Cairo township, and a deposit near Yarrow lake in Yarrow township.

Biederman Claim.—This claim (16042) is situated on the west shore of Browning lake, in the north part of Cairo township. The country rock is a red syenite in which there is a barite vein with strike N. 65° W. and dip 80° N. The

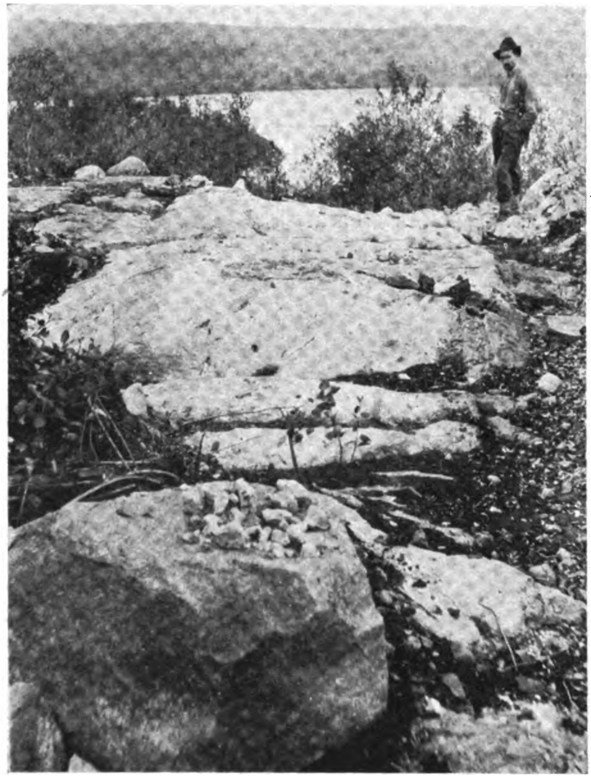


Fig. 13.—Biederman barite vein, on claim 16042, in Cairo township.

deposit can be observed about 100 feet from the shore of the lake where a shallow shaft has been sunk at a point where the vein has been concealed by drift to the east. Here there is a width of 15 feet, and the barite can be traced westerly for 100 feet, decreasing to a width of 7 feet. Beyond this there is drift followed by an exposure of barite about 30 feet in length and three feet wide at the east end, and two feet wide at the west end. The barite is for the most part quite white in colour and of good quality. At the shaft there are minor quantities of zinc blende. galena and specularite and a little fluorite, as impurities. The deposit also contains at this point some large inclusions of syenite. A sample across eight feet, on analysis contains 90.50 per cent. barium sulphate.

Yarrow Deposit.—This deposit occurs along the creek which flows from Yarrow lake to Mistinigon lake. The rocks are slate and quartzite of the Cobalt series, but they are largely concealed by a deep covering of drift along the creek. The deposit was discovered in the bed of the creek, and attempts have been made to open it up by diverting the water by means of a small dam. Two shallow pits were sunk in the bed of the creek on the barite, which is in two veins five feet and six feet wide respectively, separated by a band of quartzite. As the deposit was noted only in the creek bottom its length has not been determined, but owing to its width it is probable that it also has considerable length. This deposit, like the Biederman, will probably be of commercial value at a future time.

Iron Ore

The La Brosse claims, JS 65 and JS 66, situated in Yarrow township, a short distance west of the east branch of the Montreal river, were examined by P. E. Hopkins in August, 1914, and the following account is from his manuscript:

> The iron ore, which consists of hematite, in reniform structure and also the highly crystallized specular variety, occurs in a quartz vein that strikes N. 72° E., and dips about vertically. This vein can be traced across two claims, and varies from five feet to thirty feet in width. The iron ore occurs in isolated masses and stringers in the quartz, and in places is brecciated. On the east part of JS 66 is located the largest body of clean iron ore. This ore on the surface is sixty feet long and six feet wide at its greatest width, being in the form of a lens. Another lens is twenty-five feet in length. More work may prove the bodies to be larger, as the vein is partly drift-covered. No kidney ore was observed in other parts of the vein where exposed, but small quantities of specular iron ore occur sparingly in the vein.
>
> Iron ore was observed in small quartz veins in the vicinity in Yarrow township. The country rock that encloses the veins is conglomerate and quartzite of the Cobalt series that dip gently to the east at 10° to 15°.

Waterpower[1]

Mining camps in northern Ontario have been greatly favoured by the proximity of waterfalls capable of development for the generation of hydro-electric energy. Powell township is well situated in this regard. Big Bend or Matachewan falls lying about six and a half miles north of the Davidson and Otisse claims. This water power is located in the township of Baden on the west branch of the Montreal river at a point known as the Great Northern Bend.

Application to develop this power was made in 1916 by a firm of engineers and surveyors, Sutcliffe and Neelands, of New Liskeard, with the object of supplying electric energy to the prospective gold camp in Powell township, and possibly the Gowganda silver camp some twenty miles farther south. Regarding their exploratory surveys in 1900, De Morest and Silvester, with party No. 3, report[2] as follows:

> Matachewan falls and rapids, where the river empties into Matachewan lake, have a drop of about forty feet and constitute a very important waterpower, as the length is short and the site comparatively easy of development.

[1] The notes on Waterpower have been supplied by W. R. Rogers, Topographer for the Ontario Bureau of Mines.

[2] Report of Survey and Exploration of Northern Ontario in 1900, p. 87.

The watershed of the West branch is 790 square miles in area. Under natural head the drop at Matachewan falls and rapids is 41 feet, but a dam raising the water at the upper level to high water mark would give a head of 45 feet. Assuming a run-off coefficient of 0.3 cu. ft. per sec. per square mile of drainage area for minimum flow conditions, the possible development without storage would be about 1,000 horsepower.

Permission has been sought to raise the level of Mistinigon lake 25 feet in order to provide storage and also to increase the available head to 70 feet. Another project involves the diversion of the East branch of the Montreal river by way of Kawakinika lake, Cleaver lake and Cleaver creek, to a point on the West branch

Fig. 14.—Matachewan or Big Bend falls, Montreal river, where the West branch enters Matachewan lake.

near the centre of the township of Rankin, a route that marks a former course of the river. Such a diversion would add 210 square miles to the drainage area, making a total of 1,000 square miles, and could be effected by erecting a dam at the first rapids below Obushkong lake near the boundary line between the townships of Haultain and Morel. Both of these projects were suggested late in the fall of 1917, and either or both may not be prejudicial to other interests, such as navigation and lumbering. A Departmental examination of the feasibility of the plans had to be postponed until navigation opened in the spring of 1918. Undoubtedly work on this power will proceed in the near future, the extent of the development depending on the success met with in mining operations in the vicinity.

Acknowledgments

The writer was ably assisted in the field by J. E. Hawley, student of Queen's University, Kingston, from June 1st to late in September, after which Wm. McDonnell, of Elk lake, rendered good service till the close of the season late in October.

Geo. Bruce, Haileybury, who was in charge of operations at the Davidson claims, and J. Hollinger, in charge of the O'Connell claims, extended many courtesies to the writer while geological work was being done in the vicinity of these properties. Messrs. Bastian and St. Paul, prospectors at Fox rapids, gave material assistance in connection with the work in Cairo, Alma, and the Indian reserve.

Thanks are also due to A. J. Browning, late Mining Recorder at Elk Lake, for giving assistance to the survey party.

The assays mentioned in this report were made at the Provincial Assay Office, Toronto.

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REPORT

OF THE

Ontario Bureau of Mines, 1918

BEING

VOL. XXVII, PART II

SAND AND GRAVEL IN ONTARIO

By

A. LEDOUX

PRINTED BY ORDER OF

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SAND AND GRAVEL IN ONTARIO

By A. Ledoux

Sand and gravel deposits are very numerous in the southern and eastern parts of Ontario. The author visited the most important of these during the summer of 1917. The region examined was practically the whole area of the Paleozoic formations in southern Ontario. Manitoulin Island was not visited; on the other hand, some small parts of the pre-Cambrian belt in the counties of Leeds and Frontenac and district of Muskoka were examined. In each county several of the typical deposits have been chosen and are described with regard to their geological conditions of occurrence and their economic value.

Scope of the Report

The report begins with a review of the characteristic properties of sand and gravel, and the methods of testing applied; these properties have been divided into morphological, physical and chemical. The following chapter deals with the origin and occurrence of these fragmental rocks. Such considerations are sometimes of practical interest, as there may be a close relation between the geological origin and the qualities of sand or gravel. In numerous cases continuous lines of deposits, marking ancient lake shores, may be followed in southern Ontario. On the shores of existing lakes, certain parts are marked by extensive beaches containing abundant reserves of good building material. Attention is also directed to some artificial sands made by crushing soft sandstones, suitable for special purposes such as glass-making and iron-smelting. Several deposits of this kind are worked in Ontario.

The classification of sands and gravels is practically based upon their several uses. The principal use is in connection with building industries. Sand and gravel for construction purposes are cheap, and yield only small profits per yard or ton. Other varieties, such as moulding sand and glass sand, are of greater value, but although these materials are found in the Province, they are ordinarily imported into Ontario.

Compared with most mineral products, the selling price of sand and gravel is very low, and the margin of profit depends upon skilful and economical operation. The small operator frequently produces for a time at low cost, but by unsystematic methods destroys the value of his reserves. The larger operators should pay particular attention to the introduction of labour-saving appliances.

The last chapter deals with the distribution of sand and gravel in southern Ontario. The several counties have been arranged alphabetically; the location of every described deposit has been indicated as far as possible, by its township, concession and lot. The most important sand and gravel producing areas are shown on a general map of southern Ontario (No. 27*b*) accompanying this report.

This report should be considered as only a preliminary one. Deposits in more than forty different counties were visited during four months of field work, thus allowing only a very short time for detailed examination of any deposit. Numerous granular metric analyses and physical tests of samples have

been made; it would be desirable to make a larger number of these tests, accompanied by chemical analyses and tests of mortars and concretes made from the materials.

The writer desires to express his thanks to Prof. T. L. Walker and Prof. A. L. Parsons, of the Mineralogical Department of Toronto University, for assistance in the preparation and correction of this work. He also wishes to acknowledge his indebtedness to Prof. A. P. Coleman of the Geological Department, and to Prof. H. E. T. Haultain and R. F. C. Dyer of the Mining Department of the same institution, for valuable advice and the use of their laboratories.

Most of the experimental investigations were made at the Mineralogical Department of Toronto University.

The chemical analyses were made by the Provincial Assayer, W. K. McNeill and his assistant, T. E. Rothwell. Sketch maps illustrating the report were prepared for reproduction by W. J. Bell, Bureau of Mines Cartographer.

Statistical information has been kindly given by various city and county engineers, municipal officials and by pit owners. The writer would express to all his appreciation.

Properties of Sand and Gravel

Sand and gravel belong to the category of unconsolidated clastic rocks. The component fragments vary widely in size, some passing the 200-mesh sieve, others being more than one foot in diameter. Small grains and large fragments may be associated in the same sample. There is no natural limit between sand and gravel; for practical use, we call sand a material made of grains passing the ¼-inch screen, and gravel a material made of fragments retained on the ¼-inch screen; boulders are fragments larger than three inches in diameter.

Morphological Properties

Size.—The size of the component fragments of a clastic rock affects a certain number of its physical properties, such as specific gravity, absorption, and permeability. With regard to size, sands are ordinarily divided into fine, medium and coarse varieties, gravels into fine gravel, pea gravel and coarse gravel.

The classification of a sand or gravel is often made at sight, but more accurately by using sieves. A sieve is defined by the number of holes or meshes per linear inch; for instance, a 100-mesh sieve has 100 holes to the linear inch. A sieve may also be defined by the smallest linear dimension or *rating* of the hole, a ¼-inch sieve having holes of ¼-inch as their smallest dimension. This last method may be applied to screens with holes larger than one inch. It should be noted that there is a great difference between a 4-mesh sieve and a ¼-inch sieve, depending upon the diameter of the wire. If M represents the number of meshes to the linear inch, D the diameter of the wire in mm., the rating R is expressed in millimeters by the following equation:

$$R = \frac{25.4}{M} - D$$

The diameter D is most easily determined by means of a micrometer gauge or by microscopic measurement. The following table gives the number of meshes

to the linear inch, the diameter of the wire and the rating, for the series of sieves used in the accompanying metric analyses, except where otherwise stated:

Sieve	Diameter of wire	Rating	
Mesh	Mm.	Inches	Mm.
4	1.651	.185	4.699
8	.813	.093	2,362
10	.889	.065	1.651
20	.437	.0328	.833
28	.318	.0232	.589
48	.234	.0116	.295
80	.1425	.0069	.175
100	.1070	.0058	.147
200	.0530	.0029	.074

In some sands and gravels, the component fragments are of uniform size; in others they vary widely. This can be tested by granular metric analysis. The principle of such an analysis consists in passing a given amount of the material, say 100 to 500 grams, through a series of sieves, and weighing the amount of the sample retained on each of them after sufficient shaking. The results are given in the percentage of the whole *remaining* or *retained* on each sieve. To express the degree of fineness by a single figure, the percentages passing each sieve are added and the total divided by the number of sieves used. The result is called the per cent. of fineness; if the same set of sieves is used this figure may be used for comparing different sands and gravels. The following table gives the results of the granular metric analyses, and shows the difference in the per cent. of fineness between several grades of sand and gravel:

Sieve Mesh	A Fine Sand		B Medium Sand		C Coarse Sand		D Fine Gravel		E Coarse Gravel	
	Ret.	Pass.	Ret.	Pass.	Ret.	Pass.	Ret.	Pass.	Ret.	Pass.
4	0.0	100.00	0.30	99.70	32.85	67.15	49.80	50.20	80.00	20.00
8	0.0	100.00	3.10	96.90	39.20	60.80	63.85	36.15	83.40	16.60
10	0.0	100.00	6.40	93.60	42.50	57.50	69.50	35.50	84.65	15.35
20	0.0	100.00	16.80	83.20	54.10	45.90	79.10	20.90	87.00	13.00
28	tr.	100.00	25.70	74.30	69.30	30.70	85.55	14.45	89.45	10.55
48	1.25	98.75	60.00	40.00	93.85	6.15	94.45	5.55	98.65	1.35
80	2.00	98.00	93.25	6.75	97.95	2.05	97.55	2.45	99.80	0.20
100	5.70	94.30	98.40	1.60	98.75	1.25	98.55	1.45	100.00	0.00
200	41.50	58.50	99.15	0.85	99.60	0.40	99.30	0.70	100.00	0.00
Total		849.55		496.90		271.90		162.35		77.05
Per cent. of fineness		94.39		55.21		30.21		18.04		8.56

A: Silty sand, very fine. Camp Borden (Simcoe county).

B: Medium sand, Landshore Sand and Gravel Co. (Ontario county).

C: Coarse sand, Markus pit, Pembroke (Renfrew county).

D: Fine gravel, J. Creeper pit, Belleville (Hastings county).

E: Coarse gravel, Bray pit, Port Hope (Durham county).

The results of granular metric analysis may be represented by diagrams, taking as abscissae the ratings of the different sieves and as ordinates the percentage of material remaining on each of them. Joining the different points (fig. 1) we obtain a graphic representation of the granular metric analysis.

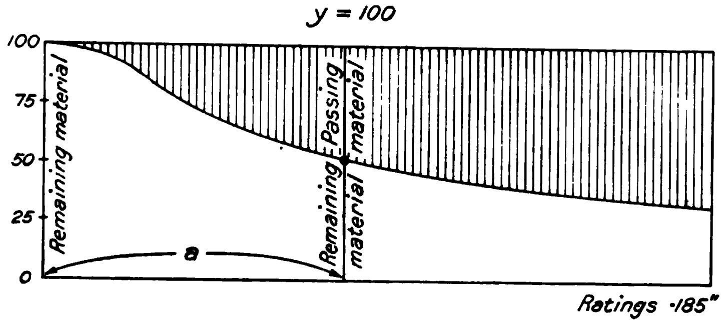


Fig. 1—Diagram of granular metric analysis. The shaded area is proportional to the fineness of the material.

On an ordinate X=a, the length measured between the curve and the axis of the abscissae indicates the percentage of material remaining on a sieve of a rating equal to *A;* the length measured between the curve and the line y=100 represents the percentage of material passing through the same sieve. The area comprised between the curve and the line y=100 is proportional to the fineness

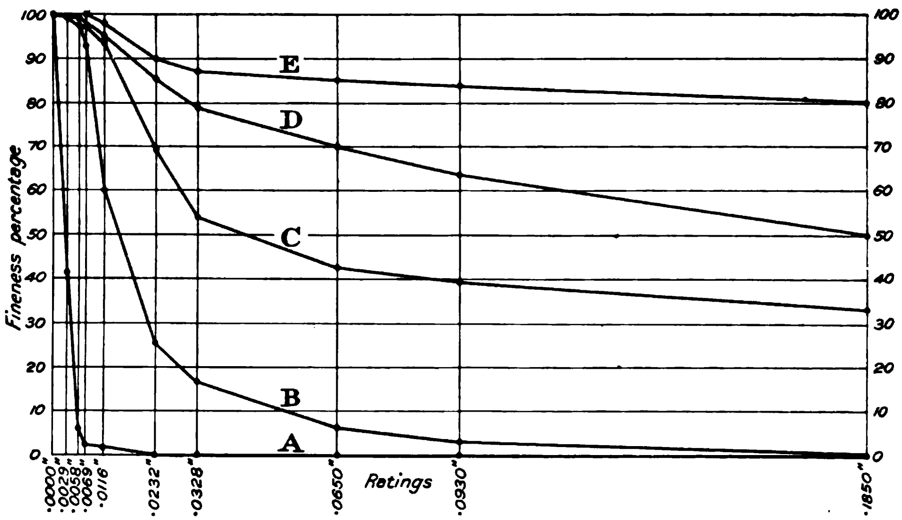


Fig. 2—Diagram of granular metric analyses of five different sands and gravels of various percentages of fineness.

of the material; for fine sand this area is large, it is smaller for medium sand, and becomes very small for coarse gravel. This system of geometrical representation (fig. 2) has been applied to the five granular metric analyses given above. All the curves start from the point 100 on the axis of the ordinates; their general shape is parabolic except near the axis of the ordinate, where there is an inversion point on the curves.

The maximum difference between the quantities of material remaining on two alternate sieves such as 4 and 10, 8 and 20, 48 and 100, etc., is a measure of the uniformity of the clastic material. This difference is called the *coefficient of uniformity*. The number of the intermediate sieve in our scale of sieves represents the *grade* of the tested material.

Shape.—The shape of the component fragments is also variable in character. In sands the grains are rounded or angular. If the latter shape is quite common to all the grains, they constitute a sharp sand, much appreciated for building purposes. The difference between a sharp and a rounded sand can be tested under the microscope; it can also be easily ascertained by rolling the grains between the tips of the fingers. For gravels a similar distinction may be established: the component pebbles are spherical, elliptical, flat, disc-like or angular: hence such terms as round gravel and sharp gravel.

Physical Properties

The following physical properties are of interest in the study of sand and gravel: Specific gravity, Percentage of voids, Permeability, Absorption, Moisture, Percentage of silt, Cementing value, Bonding power.

Specific gravity.—The specific gravity of a sand or gravel may be considered in two different ways. The *apparent* specific gravity of a sand or gravel is the weight of a certain volume of the material, divided by the weight of an equal volume of water. The *real* specific gravity is, on the other hand, the average specific gravity of the fragments composing the material. The real specific gravity is always higher than the apparent specific gravity.

The apparent specific gravity is easily obtained by weighing a known volume of the sand or gravel and dividing the weight of the material by the weight of an equal volume of water. The material should be shaken down as much as possible in order to reduce the volume of voids to the minimum.

Determination of specific gravity.—The real specific gravity of sand may be determined with a glass vessel having a narrow neck with a reference mark. This is filled to the reference mark with water at a standard temperature. A weighed quantity of the sand under examination is poured into the vessel. The pouring should be very slow in order to prevent air bubbles being carried down with the sand. The displaced water is poured from the vessel until the level is the same as before, viz., at the reference mark. This water has been displaced by the sand, and its weight divided into the weight of the sand gives the real specific gravity of the sand. The formula for calculating the specific gravity by this method is as follows:

If "W" is the weight of the sand poured into the flask, and,
"W_1" is the weight of the displaced water, then

$$\text{Real specific gravity} = \frac{W}{W_1}.$$

In order to eliminate the air bubbles, the flask containing the sample and water may be placed in an iron cylinder and connected with an air pump to produce a vacuum.

For very coarse gravels a similar method should be applied, the sample having a weight of at least 1,000 grams. The apparatus should be of metal and of a corresponding size.

Weight per cubic foot.—This value is easily obtained from the apparent specific gravity Da, and is equal to 62,484 × Da lbs.

In referring to the weight per cubic foot the physical condition of the material should be referred to as loose or compact, and the degree of moisture should be stated as wet, moist or dry. Compact sand or gravel may be described as material that has been deposited in a bin from a height or has been shaken down in a vessel.

Percentage of voids.—If Dr is the real specific gravity, and Da the apparent specific gravity, the percentage of voids (v) may be calculated from the following formula:

$$v = 100 \frac{Dr - Da}{Dr}$$

It has been found that in the case of a uniform sand made of equal spherical grains the voids vary between 25.95 and 47.64 per cent., depending upon the arrangement of the grains. In the measurement of sands containing grains of different size and of angular shape the percentage of voids was very often nearly 37 per cent., the average of the two extreme theoretical values. The voids are lower in sands made of grains varying in size than in uniform material: they are also lower in coarse sands than in fine-grained ones.

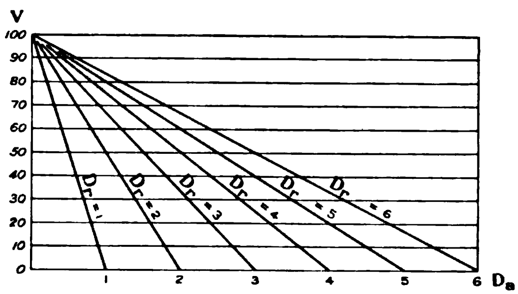


Fig. 3—Diagram of the percentage of voids (v), in function of the apparent specific gravity (Da) for different values of the real specific gravity (Dr).

Diagrams of percentage of voids in functions of the apparent specific gravity, for given values of real specific gravity are straight lines. If the apparent specific gravities are taken as abscissae, and the percentage of voids as ordinates, all the diagrams corresponding to different values of Dr converge at the point v=100 on the axis of the ordinates. The diagram for which Dr=A cuts the axis of the abscissae at a point for which Da=A (fig. 3).

The percentage of voids may be directly measured by using a beaker perforated on the side to admit a siphon, as shown in figure 4.

The beaker is filled with water, and the glass tubing acting as a siphon brings the water in the beaker to a constant level. A volume V of the material to be tested in then poured into the beaker driving a volume V of water out of the beaker through the siphon.

The percentage of voids (v) is given by the following equation:

$$v=100\frac{V-V'}{V}$$

Permeability.—While the porosity of a sand or gravel is expressed by the amount of pore space or the percentage of voids, the permeability is the quality possessed by certain of these materials to permit an easy passage of liquids or gases. This quality depends partly upon the percentage of voids, but also upon the size of the voids. It is a very important factor in moulding sands and filtering sands. If the pores are small, capillarity and friction prevent or lessen the passage of liquids and gases. Coarse material is therefore more permeable than fine grained. Sands uniform in size are also more permeable than sands of a similar grade, made up of various sizes.

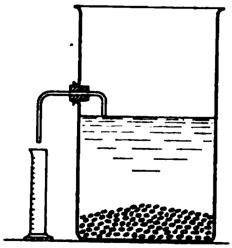


Fig. 4—Beaker for the measurement of the percentage of voids in sands or gravels.

Permeability may be directly measured by filling a tube with a given volume of the material to be tested, and measuring the time necessary for a given quantity of water or air to pass through the material.

Absorption.—On putting a sample of dry gravel or sand into water, a certain amount of water is absorbed by the fragments. The amount depends principally upon the nature of the fragments. The absorption for quartz grains is negligible, but for cleavable minerals such as calcite and feldspar it is larger, and for fragments of porous rocks, such as sandstone, still greater. To measure the percentage of absorption, a sample of the material is placed in water for about one hour; it is then removed and spread on blotting paper and when surface dry, weighed in this state. The sample is then dried over a hot plate to a constant weight. The difference in weight between the surface-dry material and the dried material, multiplied by 100 and divided by the weight of the dried material, gives the percentage of absorption.

Moisture.—The percentage of moisture is obtained by weighing a sample of the material in its natural state—as it comes out of the pit or ready for use—and the sample thoroughly dried. The difference of the two weighings, multiplied by 100, and divided by the weight of the dried sample, represents the percentage of moisture.

Percentage of silt.—This is measured as follows: A weighed sample of the dry material, about 200 grams, is placed in a broad glass tube provided with perforated stoppers and tubes at each end. The tube is placed in the vertical position and a current of water allowed to enter through the bottom and pass away through the top. The tube is shaken from time to time, and the current of water continued till it carries no more silt and is perfectly clear when coming out of the tube. The material is then again dried till the weight is constant. The difference between the weights of the material before and after the experiment, multiplied by 100, and divided by the weight of the sample before the experiment, gives the percentage of silt.

Value in concrete.—Sand is mixed with Portland cement in the proportion, 1 part cement to 3 or 4 parts of sand. The mortar obtained is moulded into briquettes used for tension or compression tests with the ordinary testing machines.

Screened gravel or crushed stone is mixed with sand and Portland cement to produce concrete. The three materials are mixed in different proportions taking into account the amount of sand contained in the gravel. Some proportions in use are:

Cement	Sand	Gravel or Crushed Stone
1	2	3
1	2	4
1	3	6

The concrete is moulded into cubes to be tested for crushing strength.

Bonding Power.—The bonding power is the property of certain sand grains to adhere more or less to one another. It is an essential quality of a moulding sand, as it permits the sand to retain in all its details the form of the mould. A dry sand made of quartz grains only, does not exhibit any bonding power. This quality is principally due to the presence of some cementing material coating the grains. This material is generally clay, though the amount of ferric hydroxide and of moisture also affects the bonding power. It is generally increased by tamping the sand, thus reducing the percentage of voids and allowing more grains to touch one another and to cement together. This property is sometimes artificially increased in foundries, by adding molasses, clay or linseed oil to the sand.

The bonding power is measured by moulding the sand into briquettes, and testing their tensile strength in a specially devised testing machine. The ordinary cement testing machine is not suitable, as it is not sufficiently delicate for testing materials of such low tensile strength.

Composition

The composition of sands and gravels may be determined either by a chemical analysis or by mineralogical examination. For most of their uses the chemical composition is of little interest, as there is no simple relation between it and the physical properties of the material. For some purposes, such as for glass-making and in chemical or metallurgical industries, knowledge of the chemical composition is absolutely necessary. A chemical analysis of sand is a long and tedious operation, and little work of this kind has been done on the several varieties of sand.

As in igneous rocks, there is a relation between the chemical and the mineralogical composition of a sand. Analyses of sand may be calculated in terms of a certain number of standard minerals, by a method similar to the one used for the quantitative classification of igneous rocks (Cross, Iddings, Pirson and Washington: "The Quantitative Classification of Igneous Rocks," University of Chicago Press, 1903). The standard minerals used in the calculations are: Calcite ($CaCO_3$), Orthoclase ($K_2O.Al_2O_3.6SiO_2$), Albite ($Na_2O.Al_2O_36SiO_2$), Anorthite ($CaO.Al_2O_3.2SiO_2$), Corundum (Al_2O_3), Magnetite ($Fe_2O_3.FeO$), Wollastonite ($CaO.SiO_2$), Grünerite ($FeO.SiO_2$), Enstatite ($MgO.SiO_2$), Quartz (SiO_2) and Water (H_2O).

An example of such a calculation follows:

SHARP SAND FROM PIT OF JOHN CREEPER, BELLEVILLE, HASTINGS CO.

	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	CO_2	H_2O	Total
Percentage	55.46	9.99	0.81	1.58	14.88	1.29	2.04	2.62	11.04	0.43	100.14
Molecular Number	.924	.098	.005	.022	.266	.032	.021	.042	.251	.024	
	......	......	......	......	251	......	......	......	251	......	Calcite ..25.10
	126	21	......	......	......	......	21	......	......	......	Orthoclase..11.68
	252	42	......	......	......	......	......	42	......	......	Albite...22.01
	30	15	......	......	15	......	......	......	......	......	Anorthite.... 4.17
	......	20	......	......	......	......	......	......	......	......	Corundum 2.04
	......	......	5	5	......	......	......	......	......	......	Magnetite 1.16
	32	......	......	......	......	32	......	......	......	......	Enstatite 3.20
	17	......	......	17	......	......	......	......	......	......	Grünerite 2.24
	467	......	......	......	......	......	......	......	......	......	Quartz ..28.02
	......	......	......	......	......	......	......	......	......	24	Water... 0.43
											Total ..100.05

This calculated mineralogical composition is called the *norm,* and should not be taken for the mode or actual mineral composition of the examined sample. A large amount of calcite in the norm indicates a sand originating from the decay of limestone. The feldspars are usually present as calculated. Corundum is a very rare constituent of sands, but its presence in the norm may be due to the presence of kaolinite or clay in the sand. Magnetite is very common as small grains in sands. Wollastonite, enstatite and grünerite are the three simplest mineral molecules entering in the composition of micas, amphiboles and pyroxenes; their amount in the norm gives an indication as to the quantity of the complex iron, magnesium and calcium bearing silicates present in the sand. Quartz is the more common constituent of sands; its percentage in the

norm is sometimes much lower than the percentage of silica in the chemical analysis, since a large amount of silica may be combined with oxides to form silicates.

A mineralogical investigation is more easily made; the sand or gravel may be examined with the naked eye, or in greater detail under the microscope. The use of heavy solutions allows a separation by gravity of the fragments, which is very useful when the material is made of two or three minerals of very different specific gravity.

Sands are in general composed principally of quartz, which frequently accounts for more than 70 per cent. of the total; the other minerals found in Ontario sands being: feldspar, mica, amphibole, pyroxene, calcite, magnetite, garnet, zircon, kaolin, and limonite. In coarse sands rock fragments are found just as in gravel. A great number of gravels, principally in the southern part of the Province along the Great Lakes, are composed of limestone pebbles with a small proportion of igneous and metamorphic rocks. The limestone accounts very often for more than 75 per cent. of the total, but in some cases the gravel is of sandstone or quartzite pebbles. Slate pebbles should not be present in a good gravel, as the cleavage and softness of slate are a source of weakness either for roadwork or concrete. On roads the slate is very soon pulverized to dust, and in concrete beams it may reduce the compressive strength 75 per cent. In the districts of Ontario near the border of the Laurentian granitic belt, the gravels are composed of igneous rocks as the predominant material.

Origin of Sands and Gravels

Sands and gravels are produced by the weathering of other rocks; and may remain in place or be transported by the action of water or wind. As a rule, the material remaining in place is the most angular, the transported material being well rounded, although some of its grains may be broken into conchoidal chips.

The principal sand and gravel deposits met in southern and eastern Ontario belong to one or other of the following types:

(1) Residuary Sands and Gravels

These represent the products of weathering of rocks which remained at their original place of formation. At the early stages of the decomposition the result is a residuary gravel, but later on each rock fragment is decomposed into smaller pieces and so on until each individual mineral grain is liberated. Of course the products more or less soluble are progressively washed away by percolating waters, and only very resistant minerals such as quartz remain as the final product of the disintegration. The grains are generally angular and the resulting sand sharp. Very often the quartz grains retain a coating of claylike material due to the decomposition of the silicates. The residuary sand generally contains about 70 per cent. of silica, and about 20 per cent. of alumina and iron oxides. The residuary deposits may be found in connection with siliceous limestones, sandstones or shales, and in such cases the original stratification may

be preserved during the weathering process. But generally these deposits are not stratified, especially when derived from igneous or metamorphic rocks. In southern Ontario some deposits of residuary sands overlie Laurentian granite.

(2) Talus Deposits of Sand and Gravel

During the weathering of rocky hills or cliffs the debris does not remain in place, but rolls down to the bottom of the cliffs where it accumulates and forms a talus deposit. This type of deposit is generally a sharp gravel containing fragments of variable size originating from the neighbouring rocks. The disintegration of the large fragments leads to the formation of a sand whose grains roll farther down the slope, forming a talus under the natural angle of repose. Such deposits are found in southern Ontario along important ridges such as

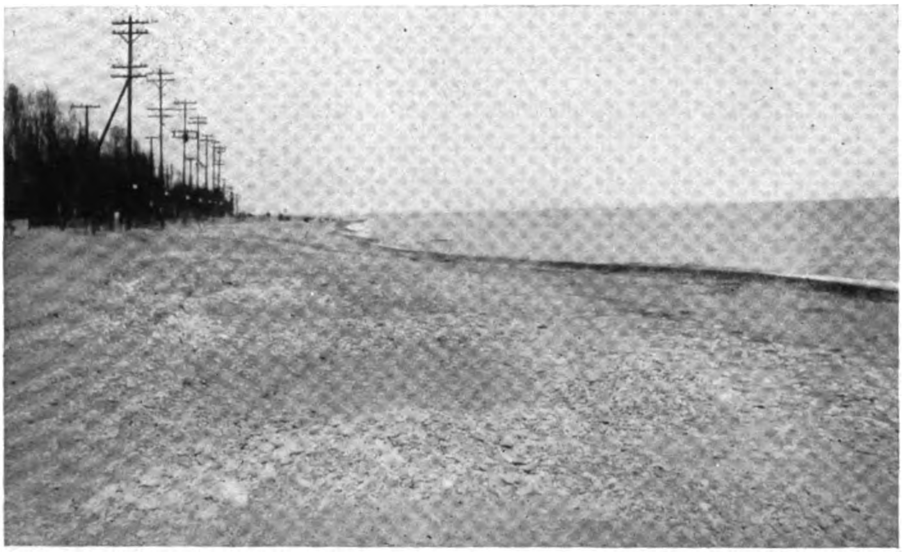


Fig. 5—Alluvial deposit on shore of Toronto Island.

the Niagara escarpment and the granitic ridge marking the southern border of the Laurentian plateau. They do not show any stratification and are generally very narrow.

(3) Alluvial Deposits

The most important of these deposits in Ontario are those formed in connection with the history of the Great Lakes (figs. 5 and 6). Extending over hundreds of miles, these ancient beaches constitute extensive reserves of sand and gravel. The grains are generally rounded and are composed of different minerals, quartz being the most abundant in the sands. The nature of the gravel pebbles depends upon the constitution of the neighbouring rocks. The alluvial deposits always exhibit stratification (fig. 6).

Alluvial deposits are formed not only on the shores of seas or lakes but also in the valleys of rivers; by repeated freshets, the solid particles carried by the water are spread over the soil and increase the alluvial deposit little by little (fig. 7). If the river passes through a lake the basin of the lake may in time be filled by the silt brought in by the river. A similar process goes on where the river flows into the sea; as the current becomes slower, the solid particles are deposited and so begins the building up of a delta.

Alluvial deposits of sand and gravel are most numerous in southern and eastern Ontario, and are generally well suited for building material.

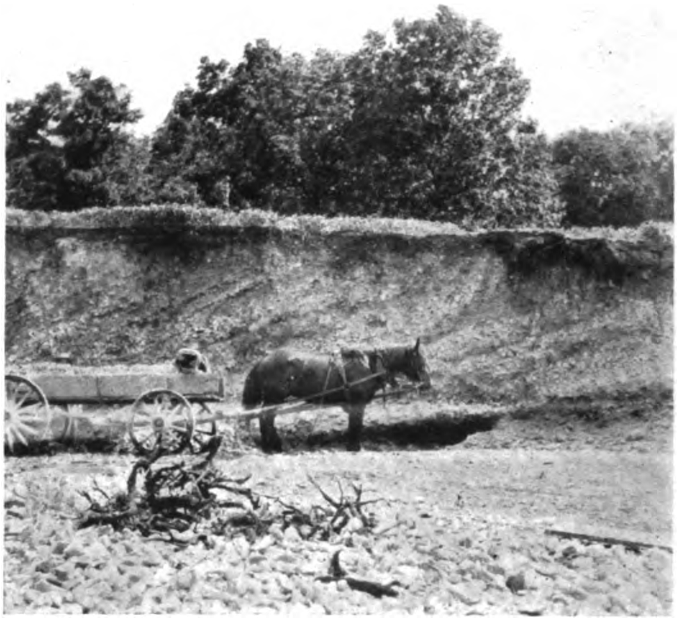


Fig. 6—Lake alluvial deposit of gravel. Note stratification.

(4) Glacial Deposits

These deposits have been brought into their present position by the action of the ice-sheet which covered, in Pleistocene time, the greater part of eastern Canada. Most of the material in these deposits consists of fragments of northern rocks. The material is very often a mixture of sand, gravel and clay, and is known as glacial drift. It is sometimes heaped up in small conical hills or drumlins, as well as in moraines of various types: ground moraine, marginal moraine, and terminal moraine.

These deposits rarely furnish pure sand or gravel.

(5) Dune Sand

This sand is carried by the action of wind. The sand resulting from the decomposition of sandstone, granite or other rocks containing quartz may be carried by the wind for long distances. The deposits formed in this way are

as a rule unstratified; while the grains are more rounded than in other types of sand. Dunes are generally grouped together in long ridges of hills at right angles to the prevalent direction of the wind.

The most important dune formation in southeastern Ontario lies on the western coast of Prince Edward county (fig. 8). Enormous reserves of sand have been accumulated there between Wellington and Sandbanks; this aeolian formation is gradually advancing inland.

Uses of Sands and Gravels

The principal uses of sand and gravel may be enumerated under the following headings:

Concrete or building sand.
Concrete gravel.
Road gravel.
Moulding sand.
Glass sand.
Filtering sand.
Locomotive sand.

Fig. 7—River alluvial deposit. Valley covered by gravel, east of Kincardine.

Concrete or Building Sand

A good concrete or building sand should consist principally of quartz grains ree from loam, dust or vegetable matter. The grains should be angular and sharp; he material should pass a one-quarter inch mesh, but not more than 15 per ent. of the grains should pass the 50-mesh sieve, and not more than 2 per cent. hould pass the 100-mesh sieve.

The tensile strength of a briquette made by mixing the sand with Portland ement in the ratio 3 of sand to 1 of cement must be similar to the tensile strength of a briquette prepared under the same conditions with standard Ottawa sand.[1]

[1] This material occurs as a large deposit of silica sand at Ottawa, Illinois, U.S. Owing to the uniformity of size and composition of this sand it is used as a standard specification sand all over this continent. The grains pass a 20-mesh and are retained on a 30-mesh screen.

There are plenty of reserves of good building sand in Ontario, but in the neighbourhood of the large towns the deposits are more or less exhausted; builders in Toronto, for instance, are forced to bring considerable quantities of sand from pits located 30 and 40 miles away.

Concrete Gravel

The best gravel for concrete is composed chiefly of very fine pebbles, approaching pea-gravel in size. The material should be retained on a ¼-inch screen and pass completely through a 1½-inch screen. The pebbles should be principally hard limestone, sandstone, or granite; pebbles of shale or other fissile rocks should not be present. The proportion of silt ought also to be a minimum.

Fig. 8—Sand dunes near Wellington, Prince Edward county.

Road Gravel

This is a coarser grade than concrete gravel, and is usually the run of the pit. Pebbles larger than two inches in diameter should be discarded or may be used in the foundation of the road, but on the upper part of the roadbed it is advisable to place finer material. The presence of shale and loam in the gravel is objectionable. Such gravel should be carefully avoided, since these materials are quickly crushed to dust by the traffic.

Moulding Sand

The essential qualities of moulding sand are its permeability to gases and vapours, its bonding power by which the sand holds the form in which it has been moulded, and its infusibility at high temperatures. The most important of these qualities is the bonding power, which depends more or less upon the amount of clay, iron hydroxide and water mixed with the sand, but the relation

of the chemical composition of the sand to the bonding power is not as yet well understood. All the methods proposed to get quantitative figures on the bonding are only approximate. A foundry foreman usually determines the bonding power by squeezing a sample in his hand, and noting whether it holds its shape.

For a long period nearly all the moulding sand used in Canada was imported into this country from the United States. There are, however, several important deposits of moulding sand in Ontario, occurring in very similar conditions to those found in the states of New Jersey and New York. In Ontario, the moulding sand appears generally as a deposit under the superficial soil, when this soil comes in contact with an underlying sand formation (fig. 9). The moulding sand, which around Hamilton and Toronto seldom exceeds more than two or three feet in thickness, seems to owe its origin to the circulation of water and to

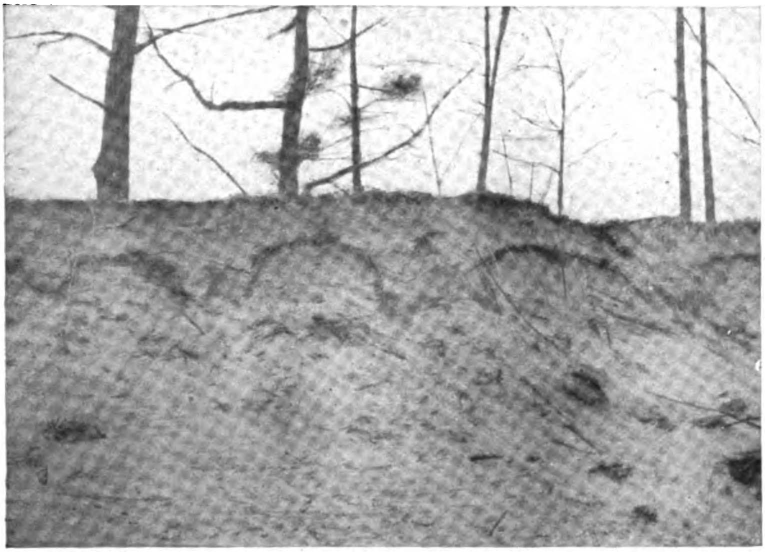


Fig. 9—Surface modification in sand formation by the roots of trees, St. John's Cemetery, Kingston Road (York county).

the action of vegetable and other organic life. It occurs in very different grades of fineness, the coarsest material being used for large and rough castings, while very fine moulding sand is used for brass and copper castings. As this is a high-priced sand which can be exploited without expensive equipment, there is a possibility of developing a considerable industry in this material for Canada.

Glass Sand

Sand for glass manufacture should be as pure as possible, and approach in composition the standard of pure silica. The constituent grains should therefore be essentially of white quartz; all other minerals, and especially the ferro-magnesian ones, must be considered as impurities. The presence of iron in the sand imparts to the glass a peculiar green colour, and seriously impairs the quality. Various processes have been proposed to neutralize this green-iron

coloration through the addition of manganese, nickel oxide or selenium. Certain iron-bearing minerals can be removed from sand by magnetic separation. As a rule a good glass sand should contain more than 99 per cent. of silica and less than 0.2 per cent. of iron oxide. A small percentage of alumina and alkalies in the form of feldspar grains is valuable in a glass sand, as it reduces the quantity of these materials to be added to the batch.

Following is the analysis [1] of a typical New Jersey glass sand:—

	Per cent.		Per cent.
SiO_2	99.40	CaO	0.008
Fe_2O_3	0.0058	MgO	0.012
Al_2O_3	0.2752	Organic matter and moisture	0.231
TiO_2	0.0737		
		Total	100.0057

The shape of the grains is without importance for glass sand. Sometimes this pure sand is obtained directly from the pits. In other cases it is prepared by crushing a more or less disintegrated sandstone, as at the plant of the Oneida Lime and Sand Co., near Hagersville.

The size should be a good medium; the majority of the grains should pass a 30-mesh sieve and remain on a 100-mesh sieve. The coefficient of uniformity ought tc be greater than 50, and the grade between 5 and 7.

The presence of grains smaller than 0.1 mm. causes the formation of "seed" in the glass.

Filtering Sand

Filtration sand or gravel must be very clean, and contain only a small amount of silt, loam, or other impurities. The fineness of the material depends upon the kind of filtration to be done. Washed material is always to be preferred for this purpose to the ordinary pit material.

Locomotive Sand

Sand for this purpose should consist of hard grains; it is used to prevent the slipping of engines and cars on railway tracks. It must be very clean and well washed material, in order to prevent the stopping of the sand pipe.

The finer grades of gravel are used on roofs. Sand is used as an abrasive for cutting and polishing stones; also as a filler for paper, as filling material for fire-proof safes, for the making of sand paper, as a raw material in pottery and brick manufacture. The production of white sand-lime brick requires a good, clean and sharp sand, quite free of alkalies.

Distribution of Sand and Gravel in Ontario

Sand and gravel deposits are very numerous in older, or southern and eastern Ontario, and may be found in every county (Map No. 27*b*). The lake shores sometimes present very good material, and they are at some places extensively dredged. Above Sault Ste. Marie, gravel is pumped out of Lake Superior. Along the Lake

[1] The Mineral Industry, 1913. Silica, p. 667. Analysis by R. B. Gage, N.J. Geol. Survey.

Huron and the Georgian Bay shores mention should be made of large deposits of sand and gravel near Collingwood (fig. 10) in Nottawasaga bay, at Owen Sound, Southampton, Port Elgin, Kincardine, Goderich and Sarnia. Sand and gravel are dredged out of the St. Clair river and sold principally at Detroit. Among the deposits located along the Canadian Shore of Lake Erie, the principal ones are the bars near Point Pelee and Pelee Island, in Essex county. Other deposits of some importance are located near Point aux Pins, at Rondeau Park; at Long Point Bay; south of Simcoe; on the bar formed in the lake at the mouth of the Grand River (Haldimand county); and at the eastern end of Lake Erie, where a large sand deposit is found in the township of Humberstone south of Sherks, the sandhills extending probably as far west as Port Colborne.

Fig. 10—Gravel formation, east of Collingwood (Simcoe county).

There is a gravel bar at the mouth of the Niagara river in Lake Ontario, which was used in building the new Welland canal. No commercial deposits occur on the shore of Lake Ontario between Port Dalhousie and Burlington, but at the latter place there is a sand bar controlled by the Burlington Beach Commission.

There is nothing of commercial value from Hamilton to Toronto, where some sand and gravel is found along the beach and on the Island at the entrance of Toronto harbour. Gravel and sand are at present being dredged from the lake at Dunbarton, Whitby, Port Hope and Frenchman's bay. Large deposits are found on the shore of Lake Ontario in Prince Edward county, near Wellington and Picton. Some sand and gravel is to be noticed along the Bay of Quinte, east of Belleville. A gravel bar is forming at the northeast extremity of Amherst island in Addington county, and another on the south shore of Simcoe island in Frontenac. Some gravel and sand is taken out of the St. Lawrence, near Brockville, and out of the Ottawa river, at Ottawa.

The largest supply of sand and gravel, however, comes from pits located on ridges or terraces marking the shores of extinct lakes or old rivers.

It has been considered useful to trace the general approximate position of the ancient shore lines of Lake Iroquois and Lake Algonquin in Ontario (Map No. 27*b*), as a great number of sand and gravel deposits are located along these shore lines. The map was compiled from the work of A. P. Coleman, T. W. Goldthwait, Frank B. Taylor, Frank Leverett, and W. A. Johnston. One of the best marked ridges of this kind is the old shore of Lake Iroquois. A series of deposits is found along this line in Ontario, from Lewiston on the Niagara river, westward to Hamilton and Dundas, and from Dundas northeastward to Trenton. (*See* map of Lake Iroquois, by A. P. Coleman, in Thirteenth Report of the Ontario Bureau of Mines, 1904). The average distance between the old shore line of Lake Iroquois and the present shore line of Lake Ontario is five miles. On the north shore of Lake Ontario east of Toronto, the Canadian Northern railway follows quite continuously the shore line of Lake Iroquois.

Old shore lines are not so definitely marked north of the present shore of Lake Erie, although a certain number of sand and gravel deposits at about five miles from the shore belong very probably to the shore of the lake when the level was 50 or 100 feet higher.

A certain number of deposits located on a ridge about 10 to 15 miles from the present shore line of Lake Huron, indicate the old shore line of glacial Lake Algonquin; it passes through Copleston and Petrolia, Parkhill, and Exeter.

Most of the sand and gravel deposits in southern and eastern Ontario are thus very closely connected with the geological history of the Great Lakes. Just as the present shore lines do not show continuous deposits of sand or gravel, the old shore lines are marked by isolated zones or areas more or less parallel to the present shore lines.

In the following description, the several counties and districts are examined in alphabetical order, and typical deposits are described in each.

Algoma District

In this very large district only the area in close vicinity to Sault Ste. Marie was visited. Three groups of geological formations appear there: (1) The pre-Cambrian granite which outcrops about five miles north of the St. Mary river at the Sault, forming a ridge very characteristic of the local topography. (2) The Ordovician sandstones of Potsdam age. (3) The Recent and Glacial formation made of gravel, sand and clay, covering the greater part of the area between the granitic ridge and the St. Mary river. This formation, principally of clay, shows a variable thickness, from 10 feet to more than 271 feet, as indicated by the records of well borings. The principal pits are indicated on a sketch map of the area around Sault Ste. Marie (fig. 11).

I. J. Downey and Sons, East Street, Sault Ste. Marie.—Some gravel is dredged for this firm at Point aux Pins, five or six miles above the Sault, by Capt. McLean, who possesses a dredging outfit.

I. J. Downey and Sons also have a gravel pit on the Canadian Pacific railway at mile 123, about ten miles east of the Sault, and just east of Garden river. Pebbles and boulders up to 6 feet in diameter were observed (fig. 12), which are principally composed of granite or gneiss.

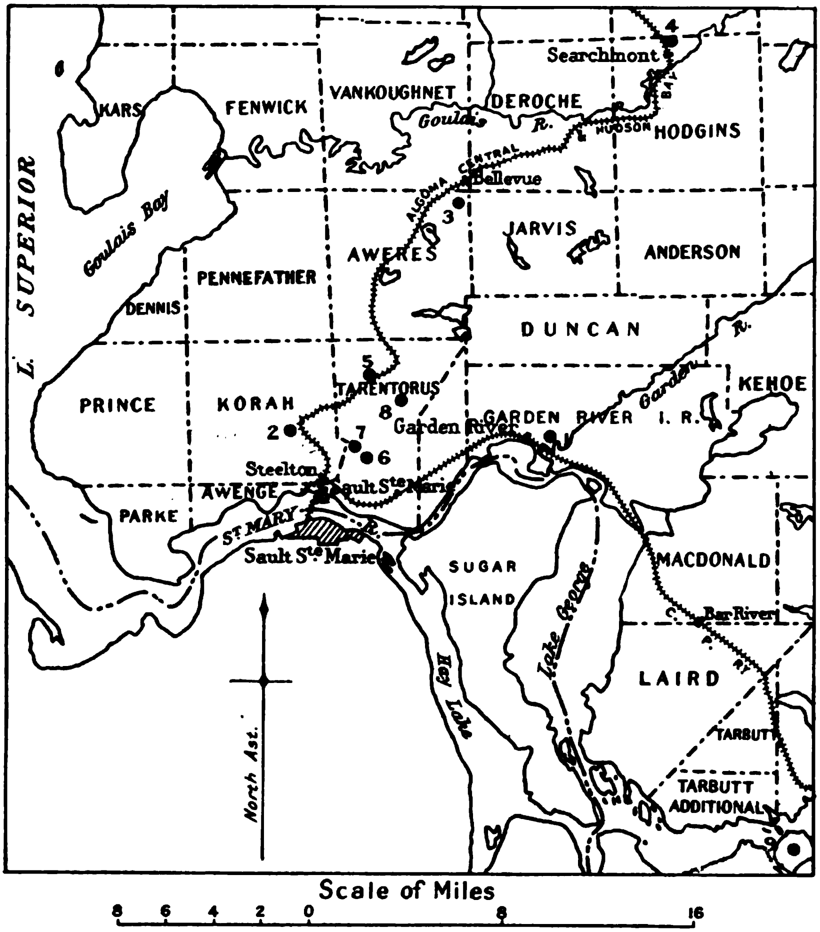


Fig. 11—Map showing location of the principal sand and gravel deposits in the vicinity of Sault Ste. Marie, district of Algoma. 1. I. J. Downey, Garden River. 2. McPhail & Wright, Steelton. 3. McPhail & Wright, Bellevue. 4. Lyons Fuel Co., Searchmont. 5. Algoma Central Railway Co. 6. Municipality of Tarentorus tp. 7. Everett, Sault. 8. The "Landslide." 9. Campment D'Ours island.

Other pebbles are of diabase or of some metamorphic rocks with pegmatite veins, or of quartzite. The pebbles are angular, and the gravel is used for ballast. The section of the pit is about 150 feet high and between 1,200 and 1,500 feet wide. There are special tracks. In August, 1917, the pit was idle; the output had been reduced in 1916, when it was about 460 carloads, averaging about 28 yards per car, or a total of 13,000 cubic yards. The production in 1912 was eight or nine cars a day, and for the whole year between 50,000 and 60,000 cubic yards. This gravel was sold at an average price of 80 cents on dock, and delivered in town at $1.50 a cubic yard.

McPhail and Wright.—This Sault St. Marie firm owns a sandpit at mile 3 on the Algoma Central railway. It is located three miles north of Steelton, and about 300 yards northwest of the city graveyard. The worked excavation is about 150 by 150 by 35 feet; 12 acres of the deposit having been already excavated. The deposit extends as far as half a mile to the northwest, and the company owns 40 acres more of it on which test holes have given between 35 and 40 feet of sand. This

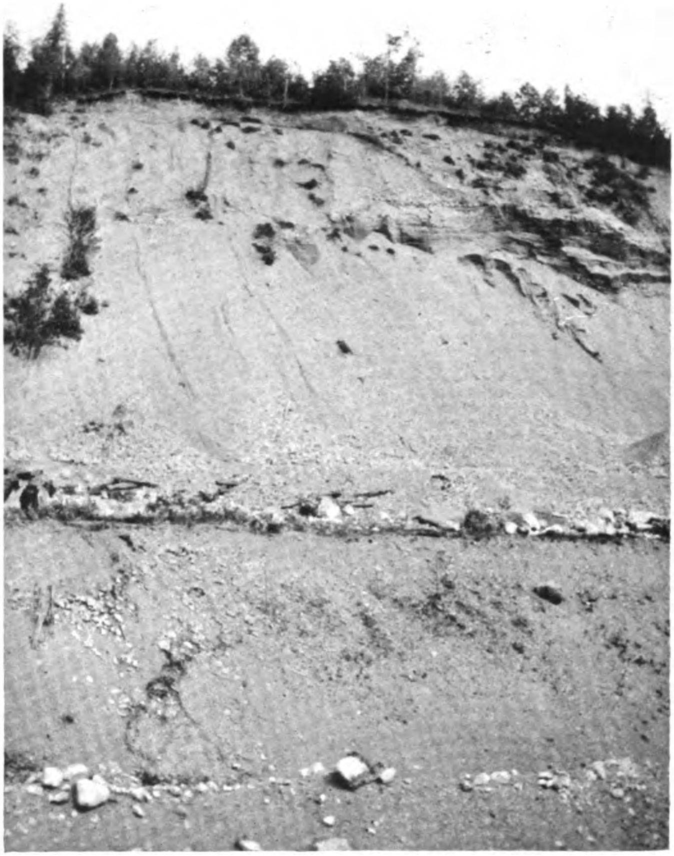


Fig. 12—Downey gravel pit, Garden River (Algoma).

sand shows generally an oblique stratification; it becomes a little coarser in the upper parts of the pit to the north. This coarse part is used for locomotive sand. The following is a granular metric analysis of this variety:—

Mesh.	4	8	10	20	28	48	80	100	200
Percentage retained ..	0.55	2.80	4.20	9.60	17.20	55.00	86.65	95.90	99.65

Per cent. of fineness, 58.72.

The average sand is used for building purposes and for making cores, but about 90 per cent. is used by the steel plants at the Sault for their blast furnaces. The ordinary building sand gave the following results by granular metric analysis:

Mesh	4	8	10	20	28	48	80	100	200
Percentage retained.	0.0	1.30	2.50	8.85	19.25	75.65	96.30	98.65	99.30

Per cent. of fineness	55.35	Apparent specific gravity	1.525
Percentage of absorption	4.9	Weight in lbs. per cubic foot	95.288
Percentage of moisture	1.73	Percentage of voids	43.5
Real specific gravity	2.701		

At the southern part of the sandpit, the surface is a little lower, and the sand near the surface a little browner and shows some bonding power, so that it is used for moulding work. There is a railway siding into the pit. Most of the work is done by hand. On an average three men are employed about 175 days a year. Two 40-ton cars are loaded daily, though the number of cars shipped in 1916 was only 163. The material is sold at $1.00 per yard delivered at the Sault, from which must be deducted the freight charge of 35 cents a yard.

Quartz Quarry.—McPhail and Wright have also a quarry of pure quartz rock located at Bellevue, at mile 21, on the Algoma Central railway. They ship from 6,000 to 8,000 tons a year of this material, which is principally used by the Algoma Steel plant. The rock has a faint pink tinge. It sells at $1.25 to $1.50 per ton f.o.b. at the quarry. The freight costs about 40 cents per ton. Mr. Warden, the chemist of the Algoma Steel Corporation, has kindly contributed the following chemical analysis of this rock:—

	Per cent.		Per cent.
SiO_2	97.25	MgO	0.16
Fe_2O_3	1.86	H_2O	...
Al_2O_3	0.25		
CaO	0.10		99.62

Lyons Fuel Co., Steelton.—This company owns a gravel pit near Searchmont, at mile 34 on the Algoma Central Railway. The output in 1916 was 29,556 yards; 15,000 yards being sold at 65 cents and the balance at 85 cents a yard. This price includes 45 cents freight rate. The bulk of the output was used for the construction of the new power canal, and the remainder for general work.

Algoma Central and Hudson Bay Railway Co.—This company has a gravel pit located along the railway near the fifth base line in the township of Tarentorus. The excavation is very large, being about 300 yards long, 40 yards wide, and probably 40 feet deep. The Root river passes through the excavation and disappears partially underground in the gravel. This gravel extends as far south as the springs of Coldwater creek, and constitutes a natural filter for the supplying of pure water in the Coldwater creek ravine. The gravel of the pit was mostly used for ballast.

The company owns another gravel pit on lots 8 and 9, in the sixth concession of the township of Hodgins. At the bottom of this pit there is a bed of sand, probably 20 or 30 feet deep, which is said to underlie the whole territory.[1] The sand which is covered by 20 to 25 feet of gravel and boulders is fine grained, as shown by the following granular metric analysis:—

Mesh	4	8	10	20	28	48	80	100	200
Percentage retained...	0.0	0.0	0.0	0.0	tr.	5.05	49.35	74.05	94.35

Per cent. of fineness	75.24
Co-efficient of uniformity	69.00
Grade	No. 7

The chemical analysis by W. K. McNeill, Provincial Assayer, of the sand from this deposit is as follows:—

	Per cent.		Per cent.
Silica	73.38	Potash	1.78
Alumina	12.14	Soda	3.58
Ferric Oxide	2.00	Water	0.73
Ferrous Oxide	2.71	Carbon dioxide	0.52
Lime	3.00		
Magnesia	0.24	Total	100.08

This sand contains too high a percentage of alumina to make a good glass sand.

The norm calculated from the chemical composition is as follows:—

		Per cent.		Per cent.
Calcite		1.20	Enstatite	0.60
Feldspars ..52.63	Orthoclase	10.56	Grünerite	3.30
	Albite	30.39	Quartz	38.70
	Anorthite	11.68	Water	00.73
Magnetite		3.02		
				100.20

The large proportion of acid feldspars and quartz plainly indicates the granitic origin of this material.

Under the microscope the sand is seen to be composed of angular grains, which for the most part are quartz, though there are also grains of tourmaline, mica and feldspar. Minerals rich in iron are absent or rare.

Tarentorus Municipal Pit.—This pit is located on the eastern side of the Great Northern road in the southwest quarter of section 29. It has produced gravel and sand for the past five years, the material being used for building purposes and road work. The ratepayers are allowed to take the gravel to put on the roads near their lots. At present the pit is a circular excavation about 100 feet in diameter and 3 to 7 feet deep. Most of the material is brown in color. The brown sand contains considerable gravel, and is of inferior quality owing to the presence of much loam. Some layers of gravel are black, the pebbles being cemented by some black material.

[1] C. H. E. Rounthwaite, engineer of the Algoma Central railway.

Everett Gravel Pit.—This pit is located about 100 yards north of the Tarentorus pit and along the west side of the Great Northern road. The size of the excavation is about 150 by 100 by 10 feet. The pit was previously owned by the city of Sault Ste. Marie. At present it is idle, and the greater part is flooded. The gravel is a little coarser than that in the Tarentorus pit. The two pits mark a gravel ridge striking across the road at N. 60° W. This ridge is from 50 to 75 yards wide, covering an area of about five acres, the average depth being 7 feet.

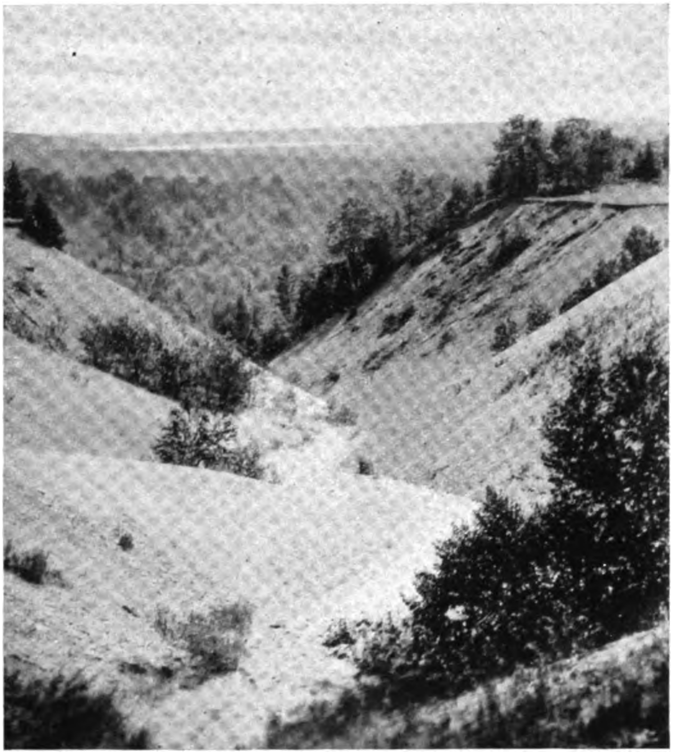


Fig. 13—Landslide along the Garden River road, near the falls of Silver creek, Sault Ste. Marie (Algoma).

Landslide Gravel.—A large amount of gravel is available at a place called "The Landslide," located about five miles north of Sault Ste. Marie, near Silver Creek falls (fig. 13). This gravel is principally composed of granitic material. A granite ridge is located a little north of the "Landslide," and makes at this point a great bend in a southeasterly direction.

Campment D'Ours Glass Sand.—White sand said to be suitable for glass-making is available on Campment D'Ours island. This island, 1,240 acres in area, is located in the St. Joseph channel, Lake Huron, near Desbarats station, on the Canadian Pacific railway. The post-office is Maclennan.

Brant County

The city of Brantford for the most part is built on beds of gravel. The principal operators of sand and gravel pits in the city of Brantford are given in the following list:—

Name and address.	Location of pit.	Nature of material.
Brantford Lands Co., Brantford	Erie Ave.........	Sand and gravel.
J. B. Stratford, Ava Rd., Brantford	W. Brantford ...	Gravel.
J. M. Callock, 53 Palmerston Ave., Brantford....	Baldwin Ave.	Gravel.
City of Brantford Corporation, City Hall	St. Paul Ave.	Sand.

Brantford Lands Co. Pit.—This pit is located on the western side of Erie Ave., in the southeastern part of Brantford. The excavation measures at present 200 yards by 150 yards by 10 feet, and has been worked for ten years. The deposit consists of gravel and sand, the pebbles being principally limestone or dolomite, with some fragments of granitic and metamorphosed rocks. About 75 per cent. of the material is limestone. The average pebbles are not larger than two inches. A granular metric analysis of this gravel follows:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained ...	54.75	60.95	63.80	72.95	84.15	95.40	98.35	99.15	99.65

Per cent. of fineness: 18.98.

The output is about 10,000 cubic yards per year, the gravel being sold at $0.40 a load of 1.25 yards. There remains a reserve of about 600 feet by 45 feet by 10 feet, a supply for two years. The material is of good quality for concrete, sidewalks and road-building. On the exhaustion of this pit other pits will probably be opened in the northwest part of the city.

The Cockshutt Plough Co. secured in 1916 about a thousand yards of moulding sand on lot No. 1, on the north side of the Brantford-Paris road, owned by Messrs. M. McEwen, J. Watkins, and T. W. Henderson, of Brantford. This farm has an area of 175 acres and is completely covered by about 1½ to 2 feet of moulding sand under 6 inches of sandy loam. This moulding sand is sold at 75 cents per yard, two yards making a load of average size.

Brantford City Pit.—This is located on St. Paul Avenue, opposite the hospital, and consists of two excavations, the eastern one being 200 by 200 by 12 feet in size, the western one 200 by 100 by 15 feet. They are separated by a sand ridge 200 feet long and 30 feet wide, this ridge being the principal reserve in sight. The sand is rather sharp, and contains a small proportion of pebbles not larger than 0.5 inch. The granular metric analysis gave the following results for this sand:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained ...	12.25	13.45	14.35	19.60	40.00	95.10	98.65	99.20	99.60

Per cent. of fineness 45.31
Percentage of absorption 0.30
Percentage of moisture 0.10
Real specific gravity 2.762
Apparent specific gravity 1.59
Weight in lbs. per cubic foot ... 99.35
Percentage of voids 42.4

There is about one foot of moulding sand at the top of this deposit.

Other Deposits.—Besides the Brantford deposits there are sand and gravel deposits in Brant county at Paris, belonging to Jos. R. Moyle, and at Mt. Pleasant belonging to the National Sand and Material Co., Ltd., Welland. There is gravel on a number of other farms near Paris, but most of the deposits have not been opened.

Bruce County

In this county the principal sand and gravel deposits are to be found along the shore of Lake Huron. Good sand and gravel beaches are found at Southampton, Port Elgin, and Kincardine. In the last-named town, the beach material is used for roads, concrete buildings, and sidewalks.

This beach extends about 40 miles north of Kincardine and about 30 miles to the south. Along the shore outcrops of limestone, gravel and sand appear. The gravel is composed principally of limestone pebbles with some fragments of granitic, igneous and metamorphosed rocks. The pebbles are various in size, some being as large as 4 inches in diameter. The gravel extends in some places as far as 1½ miles from the lake shore, and is about 5 feet deep, being most abundant and best washed near the shore.

Granular metric analyses of Kincardine gravel and sand:—

GRAVEL.

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	71.05	87.30	91.55	95.55	96.10	97.90	99.75	99.95	100.00

Per cent. of fineness 6.76

SAND.

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	4.05	5.25	5.50	5.70	6.00	30.35	95.65	99.10	99.25

SAND ANALYSIS.

Percentage of absorption 0.21
Percentage of moisture 0.0
Real specific gravity 2.673
Apparent specific gravity 1.61
Weight in lbs. per cubic foot 100.59
Percentage of voids 39.4

Carleton County

The principal market for sand and gravel in this county is Ottawa. Large quantities of these materials are dredged in the Ottawa river, near Kettle island, MacLaren island, and Duck island, east of Ottawa. All these islands are sandy with a rocky base. The average depth of the sand is three to four feet.

The principal deposits of sand and gravel near Ottawa are indicated in fig. 14.

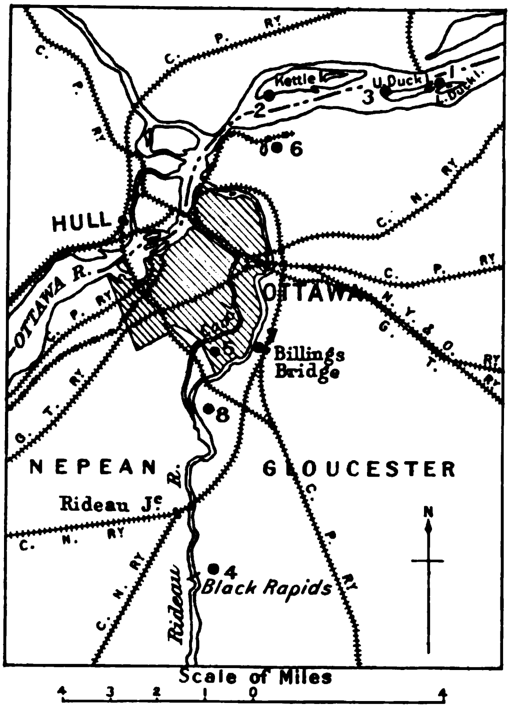


Fig. 14—Sketch map showing deposits of sand and gravel near Ottawa. 1. Beaton and Johnson. 2, 3, 4. Rideau Canal Supply Co. 5. Carnochan. 6. Chas. Keefer. 7. R. A. Nesbitt.

Beaton and Johnson, Ottawa.—This firm have a dredging outfit in the channel of the Ottawa river, near Duck island. In 1916 their total output was one hundred large loads of 120 yards per load, which sold on the wharf at 45 cents per yard. This sand is sharp and of very good quality, and is used for building purposes. The results of a granular metric analysis of this Ottawa sand follow:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.0	0.0	0.10	6.30	34.80	83.60	92.95	97.20	99.60

Per cent. of fineness	53.94	Apparent specific gravity	1.56
Percentage of absorption	0.33	Weight in lbs. per cubic foot	97.48
Percentage of moisture	0.27	Percentage of voids	40.6
Real specific gravity	2.626		

The Rideau Canal Supply Co.—This company also dredges a large quantity of sand near Duck and Kettle islands. In 1916 its output was 19,260 yards, which was sold for delivery in Ottawa at 90 cents a yard. It is all used for cement work.

The same company has a sandpit near Black rapids, on the Rideau river, about five miles south of Ottawa. The pit is 60 feet deep and covers an area of one acre; there are 14 acres in reserve. The output in 1916 was 9,493 yards. For delivery in Ottawa the price is 90 cents per yard. This sand is used for building purposes, and asphalt work.

Carnochan's Sand and Gravel Pit.—Mr. Carnochan owns a pit in the southwestern part of Ottawa, between Hopewell avenue and Glen street, west of Leonard street. This pit is 60 feet by 100 feet in area, with an average depth of 10 feet and a maximum depth of 20 feet. It was opened twenty years ago. The upper 12 feet are gravel, with the largest pebbles on top. In general these pebbles are not larger than four inches, and are principally limestone, angular in shape. Eight feet of good sharp sand, mixed with small pebbles, underlies the gravel. The stratification is oblique and irregular, and indicates a delta formation. The deposit is not nearly exhausted, but the pit cannot well be worked much longer owing to near-by buildings. The present output is about 200 yards per year, and sells at an average price of 70 cents a yard at the pit.

Rockcliffe Sand and Gravel Pit.—Ch. Keefer, 310 Bank Building, Sparks street, Ottawa, kindly furnished the following information about the deposit he works in the northeastern part of the city, known as Rockcliffe sand and gravel pit. The location of this deposit is Block 15 B of lot 2, junction gore of the township of Gloucester, near the shore of Hemlock lake. The whole area is 34 acres, of which 17 are sand and gravel. The area worked up to the present time covers 4½ acres, the average depth of the workings being 15 feet. The pit supplies principally sharp sand, which has been extensively used for concrete work in Ottawa. The output in 1916 was 2,854 yards of sand, which sold at 25 cents a yard at the pit. The following tests were made by the testing laboratory of the Public Works Department at Ottawa, in December, 1913.

Granular metric analysis:—

Mesh	4	8	10	20	30	50	80	100	200
Per cent. retained.	0.	0.	0.	6.2	42.9	75.8	93.6	95.2	98.6

Per cent. of fineness, 54.19

N.B.—This value of the per cent. of fineness should be used for an approximate comparison only with other values given in this report, as the analysis was made by means of a different series of sieves.

Real specific gravity	2.64
Apparent specific gravity	1.45
Weight in lbs. per cubic foot	90.60
Percentage of voids	45.3

Tensile strength—Mixture 1: 3

7 days	Standard sand	306 pounds
	Rockcliffe sand	322 "
28 days	Standard sand	356 "
	Rockcliffe sand	362 "

The bottom of Hemlock lake is composed of sand, and large reserves could be worked by a pumping dredge.

R. A. Nesbitt's Sand and Gravel Pit (south of Ottawa).—This property is located east of the Rideau river a little north of Billings Bridge. There are two pits of 250 feet in diameter near the River road, Stanley road and Billings avenue. The whole block is about 3 acres in area. The greatest part of the deposit is worked out, and the wall is close to buildings. This wall is 14 feet high; the upper five feet are loamy and mixed with large stones without value. Then comes one foot of sharp sand and under it three feet of gravel, which is mixed with at least 60 per cent. of sand. The pebbles are between two and four inches in size, and about 90 per cent. of them are limestone, the remainder being primarily granite and gneiss. Under the gravel is two feet of sharp sand, and as one goes deeper this sand becomes much finer. This material was sold at 75 cents a yard for the gravel, and 50 cents a yard for the sand at the pit.

J. Blair's Pit.—There are some deposits of sand southeast of Arnprior, in the northwest corner of the county of Carleton. One of the most important is J. Blair's pit, in the township of Fitzroy, lot 22, fourth concession. The pit is at present 200 by 60 by 25 feet. The upper three feet are loam, and then there are 22 feet of gravel. The pit is located three miles from Arnprior, near the G. T. Ry. tracks. The G. T. Ry. Co. estimates that there are 15 million yards in reserve on an area of about eight acres. The gravel is composed of rounded pebbles of limestone and granite and other materials averaging from one to two inches in diameter. At the north end of the pit sharp sand of good quality overlies the gravel, the contact dipping to the north at an angle of 40°. This sand is not worked at the present time, but the gravel is used for roadwork and ballast. The approximate output in 1916 was 500 yards, sold at 25 cents per load of 1½ cubic yards.

Granular metric analysis of gravel from Blair's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	97.15	97.50	97.60	97.85	98.05	98.75	99.25	99.50	99.80

Per cent. of fineness 1.84
Coefficient of uniformity 97.50
Grade .... No. 1

Patterson's Gravel Pit.—Mr. Patterson, of Arnprior, owns a pit in Fitzroy township, lot 27 in the third concession, which is 300 by 100 by 15 feet and contains layers of coarse sand, and pea gravel showing sometimes auto-cementing properties. Mixtures of 1 to 7 make good concrete with this gravel. The output in 1916 was 500 yards, which sold at 20 cents per ward. There is a reserve of two acres of gravel on this property.

Dundas County

In this county the principal deposits are located in the townships of Williamsburg and Matilda, around Williamsburg, Morrisburg and Iroquois (fig 15).

Styles' Sandpit.—On lot 16, first concession, township of Williamsburg. This pit lies about four miles east from Morrisburg station, north of the Grand Trunk railway and half a mile north of the St. Lawrence river. The sand in this region forms a ridge of drumloid hills. The upper two feet of the deposit are loamy and the material is not used. Under the loam are 11 ft. of good sharp sand used for building concrete and sidewalks. The principal hill worked at present is 100 yards long and 30 yards wide. The ridge extends to Morrisburg, but the sand becomes too fine in size and of poor quality toward the west. The

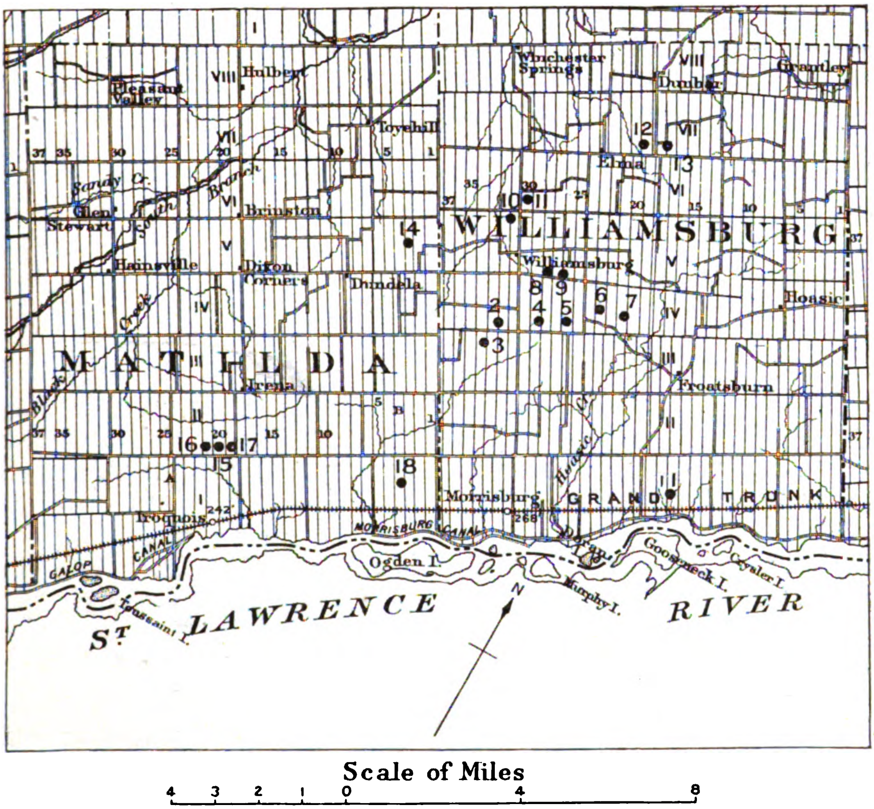


Fig. 15—Map showing location of sand and gravel deposits in the southern part of Dundas county. Sand pits:—(1) Styles, (17) Armstrong. Gravel pits:—(2) Shanette, (3) Coghlan, (4) Froats, (5) Hall, (6) Colquhoun, (7) D. Gillard, (8) Carlough, (9) Casselman, (10) Whittaker, (11) Weaver, (12) and (13) McMillan, (14) Merkeley, (15) Shaver, (16) Brouse, (18) Beckstead.

output of this pit is about 100 cubic yards a year, and is sold at 50 cents a yard at the pit and $1.75 delivered at Morrisburg. There is an available reserve of at least 10,000 cubic yards.

Shanette's and Coghlan's Gravel Pits.—The former is on lot 34, concession four, and the latter on the same lot in concession three, Williamsburg township. These pits are located on both sides of the third concession road and west of the road from Morrisburg to Williamsburg. The gravel strata are 10 feet higher than the level of this road, the upper part being of large pebbles

or boulders, generally of a dark blue crystalline limestone. In the lower part, smaller pebbles become more abundant, the gravel being more sandy at the bottom. The pebbles average three inches in size, and they consist predominantly of Silurian limestone containing numerous fossil shells. Some granitic and metamorphic pebbles are also present. The Shanette pit is an excavation 150 by 30 by 8 feet. The Coghlan pit is newly opened, the gravel being exposed for a length of 120 feet. These deposits are part of a forest-covered ridge and contain a reserve of 2½ acres.

Granular metric analysis of Shanette's pit gravel:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	67.15	73.25	76.85	87.05	93.15	98.75	99.55	99.70	99.85

Per cent. of fineness 11.63

N.B.—The pebbles remaining on the 4-mesh sieve include 46 per cent. larger than 1 inch, and 21.15 per cent. smaller than 1 inch, or total 67.15 per cent.

Harry Froat's Gravel Pit.—On lot 29, concession four, Williamsburg. This deposit is nearly exhausted, and comprises several small pits lying under water. There remains in reserve an area of about 50 yards by 20 yards, the gravel having a depth of nearly 5 feet. This material is used as cement gravel, and sells at 50 cents a yard at the pit.

Hall's Gravel Pit.—On lot 26, concession four, Williamsburg, there is an excavation of 150 by 30 by 3 feet. The pebbles, which are predominantly of limestone with some granite, sandstone, and quartz, are large in size and mixed with boulders.

R. Colquhoun's Gravel Pit.—On lot 23, concession four, Williamsburg. The pit is at present 100 by 50 by 4 feet in size. It lies behind the farm buildings at the top of a ridge, on which there remains half an acre in reserve. Most of the material is subangular limestone gravel, with numerous boulders. The lower part of the pit is more sandy.

David Gillard's Gravel Pit.—On lot 21, concession four, Williamsburg. This pit, which has been idle for some years, is 100 by 40 by 5 feet in extent, with a great variety of pebbles of limestone and igneous rocks. The reserve covers about one acre.

Jacob Carlough's Gravel Pit.—On west half lot 28, concession five, Williamsburg. The excavation, which is 200 by 100 by 6 feet, is located on a hill running in northeast-southwest direction. The average pebbles are 3 inches in diameter, but towards the east the pebbles are larger and interspersed with boulders. No gravel has been sold from this pit for several years.

Miss Casselman's Gravel Pit.—On lot 27, concession five, Williamsburg. The excavation is 200 by 100 by 4 feet. The pebbles are angular and of different sizes down to 4 inches in diameter; they consist of limestone, metamorphosed and igneous rocks, and become more sandy in the lower parts. The material is used as concrete and road gravel.

H. M. Whittaker's Gravel Pit.—On lot 31, concession four, Williamsburg. This pit is located about three-quarters of a mile north of Williamsburg, on a ridge running approximately in a north and south direction. The deposit has

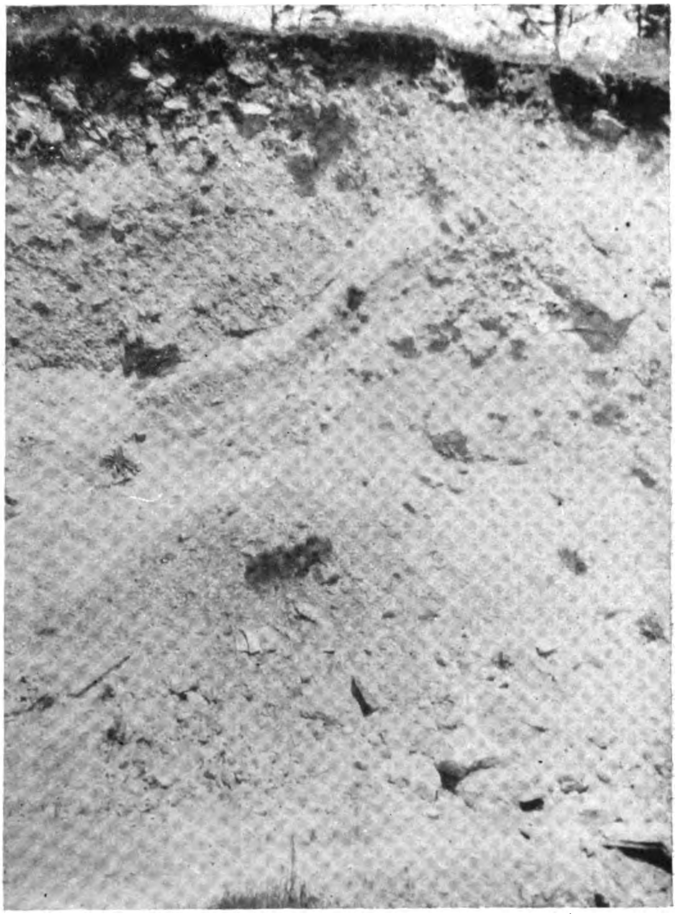


Fig. 16—Whittaker pit, showing inclined stratification, Williamsburg, Dundas county.

been worked from the north, on an area of 500 yards by 40 yards, the wall becoming higher at the southern part, where it is 15 feet high. The stratification is oblique (fig. 16) the layers dipping at an angle of 30°. The seams are of different grades and about one foot thick; there is a little loam and about 40 per cent. of the deposit is sand, a portion being blue and calcareous. There are some large boulders, but most of the gravel consists of angular pebbles of limestone and granite, not exceeding two inches in diameter. Eruptive and metamorphosed rocks are more abundant among the large stones than among the

small pebbles, where limestone is predominant. This gravel is at present used for concrete making in a bank building at Williamsburg. One team hauls about 10 loads a day from the pit to Williamsburg. The available reserve extends over four acres south of the present pit.

Thomas Weaver's Gravel Pit.—On lot 30, concession six, Williamsburg. This pit is located on the northeast prolongation of the Whittaker pit, and was closed two years ago. The ridge extends still farther in a northeast direction, but is all under crop.

Arthur McMillan's Gravel Pit.—On lot 18, concession seven, Williamsburg. This pit is located about one mile east of Elma, on both sides of a north and south road to Dunbar and Chesterville. The gravel ridge has a direction N.60°E. The gravel is of good quality, consisting principally of limestone with a certain amount of igneous material. The average pebbles are 2 to 3 inches in diameter; large pebbles being scarce. The excavation on the west side of the road is 300 by 90 by 6 feet; that on the eastern side 600 by 200 by 4 feet. The pits are completely covered with vegetation and have not been worked for several years. The reserve extends over 4 acres.

Charles Merkeley's Gravel Pit.—On lot 2, concession five, township of Matilda. This pit is located near the road from Williamsburg to Dundela. About 600 by 100 by 4 feet have been taken out, but work has been discontinued for several years, although there seems to be an equal reserve lying north of the pit, under the orchard. The work was to start again this year, as one-quarter of an acre of this property was sold to the council of Matilda township.

Edgar J. Shaver's Gravel Pit.—On west half lot 20, concession two, Matilda township. This pit is southwest of the Iroquois graveyard. It is about 100 by 50 by 7 feet. There are large stones at the top, but the lower 5 feet are of good limestone gravel, the pebbles being on an average 1 to 2 inches in diameter. This material sold this year at 75 cents a yard.

Brouse's Gravel Pit.—On lot 21, concession two, Matilda. The excavation has the form of a circle, 100 feet in diameter. There are 6 feet of grey sand at the top on the eastern side, and under it the gravel formation is 10 feet thick. The gravel is similar to that from the Shaver pit, the pebbles being a little larger.

Armstrong's Sand Pit.—On lot 19, concession two, Matilda. The pit is 200 by 100 by 12 feet in size, and is not worked at present. There is a reserve of good building sand about 200 by 100 by 6 feet in sight. Some large stones, probably rejected from the gravel, have been dumped in the centre of the pit.

Granular metric analysis of Armstrong sand:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.0	0.35	0.50	1.30	3.65	33.50	70.90	86.90	97.50

Per cent. of fineness	67.27	Weight in lbs. per cubic foot	96.23
Real specific gravity	2.713	Percentage of voids	43.2
Apparent specific gravity	1.54		

Albert Beckstead's Gravel Pit.—On lots 3 and 4 in concession one, Williamsburg township. The excavation is now 150 yards by 20 yards by 2 yards (average). On the top of the ridge there is about 1½ feet of loam and under it 8 feet of gravel. There is a reserve of about 75 yards by 20 yards by 2 yards. The gravel is composed of angular pebbles, principally limestone. These vary in size from one-tenth to five inches, while some boulders reach 1 foot in diameter. The proportion of sand is small. This gravel was used for concrete making in the Morrisburg canal, as well as for bridges, houses and road building. It was sold at 50 cents a yard at the pit and $2.00 for delivery in Morrisburg. The output is at present small, although in some years it reached 1,000 yards.

Durham County

In this county there are some sand and gravel deposits around Port Hope and Bowmanville.

Thos. A. G. Bray's Gravel Pit, Port Hope.—On lot 2, concession four, township of Hope. The excavation is 150 by 150 by 4 feet, the available reserve covering an area of 7 acres. The top of the deposit is covered by boulder clay under which there is a coarse gravel consisting of large pebbles and then about 5 inches of limestone gravel, mixed with about 20 per cent. of sandy material.

Granular metric analysis of limestone gravel:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	80.00	83.40	84.65	87.00	89.45	98.65	99.80	100.00	100.00

Per cent. of fineness, 8.56.

The 80 per cent. remaining on the 4-mesh sieve is composed of 48.05 per cent. pebbles larger than 2 inches, 17.85 per cent. nut pebbles about 1 inch in diameter, and 14.10 per cent. pea gravel smaller than 1 inch.

Hiram Walker's Gravel Pit, Port Hope.—On lot 18, concession three, Hope. The pit lies on top of a rounded hill. The present excavation is 300 by 150 by 4 feet in size, but gravel was found to a depth of 8 feet. The available reserve is approximately 1,200 by 150 by 4 feet. The pit is located one-quarter of a mile south of the Canadian Northern[1] Railway tracks. The gravel is composed of limestone pebbles which at the top are large, but smaller near the bottom, where they are mixed with a certain amount of sand. This deposit extends in a northerly direction through concession four, where it has been worked largely by the C. N. R. for ballast.

There are several other gravel deposits at an average distance of six miles north from the Lake Ontario shore at Port Hope. These deposits belong to the old Lake Iroquois beach, and are abundant near Quay. This shore line of Lake Iroquois is very well marked through the whole of Durham county, and the

[1] Now, since change to Government ownership, called Canadian National Railways. See also on subsequent pages.

C. N. R. tracks follow more or less this line of gravel deposits. Some deposits are located outside of this general ridge, this being the case for the gravel pits lying north of Port Hope and Charlecotte.[1]

Gravel pits, Hope township.—On lot 9, concession two, behind the Pomeroy house is a circular pit 100 feet in diameter by 12 feet in depth. The gravel is very coarse at the top and finer near the bottom; it is principally composed of limestone. Fifty yards west of this pit is a second circular pit about 200 feet in diameter and of similar character. A little farther north on the west side of the road there is a third pit worked for road gravel by P. Sleemon, of Port Hope. The excavation is 200 by 150 by 12 feet in size. At the time of the writer's visit, it was worked by 9 men and 5 teams. The gravel was sold at 15 cents a yard.

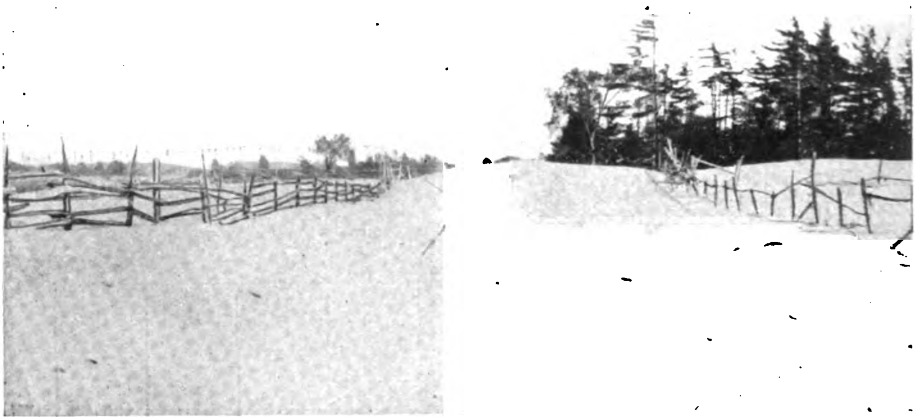


Fig. 17—Inland dune, invading cultural areas, north of Charlecotte, Durham county.

Sandy formation between Charlecotte and Clarke.—This formation extends along the road between Charlecotte, Hope township, and Clarke, in the township of Clarke, as a ridge of sandy hills. It lies in concession two of Hope township and concessions one and two of Clarke township. The reserves are very large, and at some places gravel pits have been opened, but the greatest proportion of the deposit is a fine ferruginous sand which was used for making mortar. This sand, as it contains almost no bonding material and is unprotected by vegetation, is transported by the wind over the adjacent agricultural lands, forming inland dunes (fig. 17).

Similar formations occur around Kendal and Orono.

Sand and gravel on shore of Lake Ontario at Port Hope.—This beach is composed principally of recent sand, which has been shipped by the carload for building purposes. The beach is about 60 yards wide near the station, where there is also some fine limestone gravel. Farther west the beach narrows to 3 or 4 yards, and the gravel becomes coarser, certain pebbles being 4 inches in diameter.

[1] See L. Reinecke, Road Material Surveys in 1914, Geological Survey of Canada, Memoir 85, pp. 141 *et seq.*

Granular metric analysis of lake shore sand, Port Hope:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.0	0.0	tr.	0.10	0.35	17.55	87.15	97.25	99.75

Per cent. of fineness 66.43
Apparent specific gravity 1.62
Real specific gravity 2.706
Weight in lbs. per cubic foot 101.22
Percentage of voids 40.1

Township of Darlington.—In the immediate neighbourhood of Bowmanville there are no important deposits of sand or gravel, but farther north there are some deposits near the C. N. R. tracks along the old Lake Iroquois beach principally near Tyrone station. The pits are generally small, and the deposits not very deep. The gravel contains about 75 per cent. of limestone pebbles. Beds of good sharp sand alternate sometimes with the gravel beds. Great quantities of this gravel were used for ballast, but there remains yet along this old shore line in the township of Darlington an available reserve of more than one million cubic yards.

Elgin County

There are several deposits round St. Thomas and Port Stanley. M. U. Ferguson, the city engineer of St. Thomas, kindly furnished information and assistance respecting these deposits. Gravel is very abundant in the city of St. Thomas, where it occurs in Kettle creek as river-washed gravel, and there are also pit deposits. The creek gravel is good concrete gravel, but, lacking bonding material, is not suited to road making. The pit gravel contains enough clay to make good road gravel, but is not good concrete material.

Ponsford's Gravel and Sand Pit, St. Thomas.—This pit is in the township of Yarmouth, on lot 17, concession eight. The excavation is about 500 by 250 by 20 feet; there are about 12 to 14 feet of gravel on the top and 6 to 8 feet of sand at the bottom. There is at least an area of 50 acres in reserve. The upper part of the deposit consists of alternate layers of gravel of various coarseness: the pebbles range in size up to 4 inches in diameter. Limestone is predominant, and accounts for 60 per cent. of the whole material, the remainder being granite, gneiss, etc. Some parts of the fine material are sharp and contain no clay; other parts nearer the surface are mixed with clay. The sand is screened and used in the manufacture of silica bricks. The output of this pit in 1916 was 2,700 loads (about 4,000 yards) of gravel, which sold at 40 cents a load.

Granular metric analysis:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	5.5	8.6	10.8	16.4	21.85	49.00	84.45	96.75	99.45

Per cent. of fineness 56.35
Real specific gravity 2.774
Apparent specific gravity 1.69
Weight in lbs. per cubic foot 105.59
Percentage of voids 39.1

City of St. Thomas Pit.—This pit is located behind the city park and supplies gravel and sand. The pebbles are not larger than half an inch in diameter. It makes a good pea gravel in macadam roads as a binder between larger pebbles. The sand is sharp and used for mortar making. The output in 1916 was 2,700 yards.

Granular metric analysis of gravel:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	24.60	34.45	39.75	50.25	59.50	86.20	96.10	97.40	98.30

Per cent. of fineness, 34.83.

Axford's Pit.—This pit is located southwest of the city pit, and the material is coarser, there being less sand and more gravel, the latter of good quality for concrete. The wall of the pit is 15 feet high and the reserve covers 40 acres.

Gravel within the city limits of St. Thomas.—In excavating for the construction of sewers and waterworks in St. Thomas, 3 or 4 feet of gravel of good quality were found underlying the whole city.

Sand deposit at Port Stanley.—On both sides of the Kettle valley running into Lake Erie, there are very high ridges made of silt and sand lying on a blue clay. The contact between the two formations is about at the lake level, and constitutes a line of weakness along which the clay is washed away so that the overlying sand and silt crumbles down. The ridge is between 100 and 150 feet high. This process of undermining is going on steadily. The sand and silt are of little importance for economic purposes. A little garnet sand and some coarse and sharp building sand are found on the beach.

Essex County

The most important deposits in this county (fig. 18) and among the largest in all Ontario are on the sand and gravel bars in Lake Erie near Point Pelee and Pelee island. There are some other gravel deposits near Leamington, and along the electric railway between Leamington and Windsor, and also south of Windsor, near Ojibway. In many creeks running south and north through this county, the gravel accumulates in the bends. In the pits, gravel and sand generally occur in alternate layers and the gravel is very often sandy.

Point Pelee; Cadwell Dredging Co., Windsor.—This company owns eight dredges each carrying 75 carloads of gravel which can be loaded in two and a half hours. The output in 1917 from the opening of navigation till the end of August was 151 dredge loads.

Point Pelee forms a peninsula in the shape of an acute triangle, the centre of Pelee island lying about 12 miles south of the point. The peninsula is continuously reduced in size by the washing of the lake, and since 1913, 1,300 feet have been removed from the end of the Point. The life-saving station erected by the Dominion government in 1914, 200 feet from the eastern shore, is now

only 90 feet from the shore, and during strong gales the bottom of the boathouse is washed by the waves. In April, 1917, it was 800 feet north of the end of the end of the peninsula, but in August of the same year this distance was reduced to 500 feet.

The area worked by the Cadwell Dredging Co. extends as a bar to the west of the peninsula and stretches from three miles south of the point to two miles

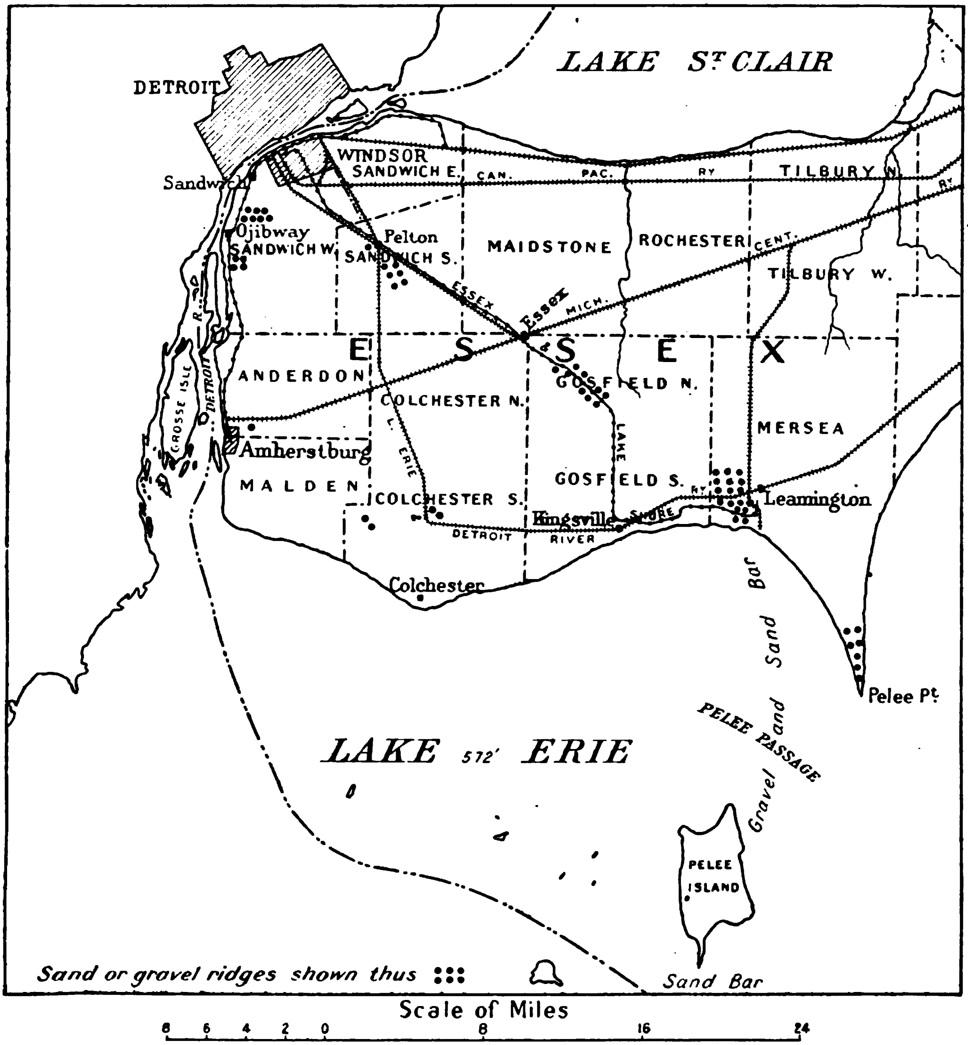


Fig. 18—Sand and gravel deposits in Essex county.

north. The dredges work about one mile from the point. South of Pelee island most of the gravel has been removed and only sand remains. It is very probable that the material taken from the bar south of Point Pelee is replaced by sand and gravel coming from the point. The peninsula is composed principally of gravel and sand layers which may be seen on both shores. Near the shore there

is a little zone, 20 feet wide, of sharp white sand, then comes a zone of gravel about 6 feet wide, and higher up a zone of very fine red garnetiferous sand. The southern part of the peninsula is covered by trees, mostly cedars. Three or four miles north of the point, where the peninsula becomes wider, sand dunes and sand ridges appear parallel to the western shore. They are about 10 feet high and consist of very white, fine sand. Farther north, the clay is nearer to the surface, and a clay dike has been built up to protect the farm land from incursions of the lake.

Nearer Leamington, sand and gravel are seen only in a narrow strip along the lake shore, the central part of the peninsula being composed mostly of silt and clay and constituting a fine agricultural region. Fifty rods from the shore the bottom of the lake is clay, the average depth being 15 feet. This clay also underlies the Pelee peninsula, and its gradual destruction is due to the washing away of the clay by a process similar to the one noticed at Port Stanley in Elgin county.

Most of the material dredged near Point Pelee goes to Cleveland, Toledo, and Detroit, in the United States.

Granlar metric analysis of white sand from shore at Point Pelee:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0	traces	0.50	10.60	37.30	83.65	98.05	99.65	99.80

Per cent. of fineness 52.27
Real specific gravity 2.664
Apparent specific gravity 1.667
Weight in lbs. per cubic foot ...104.161
Percentage of voids 37.4

Granular metric analysis of garnetiferous sand, Point Pelee:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0	0	0	0.20	1.05	40.05	92.60	99.20	99.90

Per cent. of fineness 63.00
Real specific gravity 3.403
Apparent specific gravity 2.165
Weight in lbs. per cubic foot ...135.278
Percentage of voids 36.4

Sandwich West township.—A ridge containing both sand and gravel is to be seen, south of Windsor, near Ojibway, on the property of the Canadian Steel Corporation, Ltd. This company expects to obtain 30,000 yards of sand from this deposit, though it may be necessary to remove an equal amount of overburden. There is about 8 to 10 feet of sand or gravel over the glacial boulder clay. This deposit was not being worked in August, 1917.

Frontenac County

This county is as a rule rocky, and sand deposits are not common. Some pits are located at Glenburnie and Cataraqui, and sand from the shore of Lake

Ontario is obtained, principally at Big Sandy bay, on the southwest corner of Wolfe island. Professor M. B. Baker suggested in a recent report[1] that the white lower beds of Potsdam sandstone might be valuable as a source of glass sand, as they are free from iron.

The Kingston Sand and Gravel Co., Raglan Road, Kingston.—The sand brought to Kingston by this company comes from pits located at Glenburnie, 7 miles north of Kingston. Between Kingston and Glenburnie, the north and south road runs through the Ordovician limestones. A sand ridge is situated east of Glenburnie in the direction of Maple Lawn. The pits are in concession

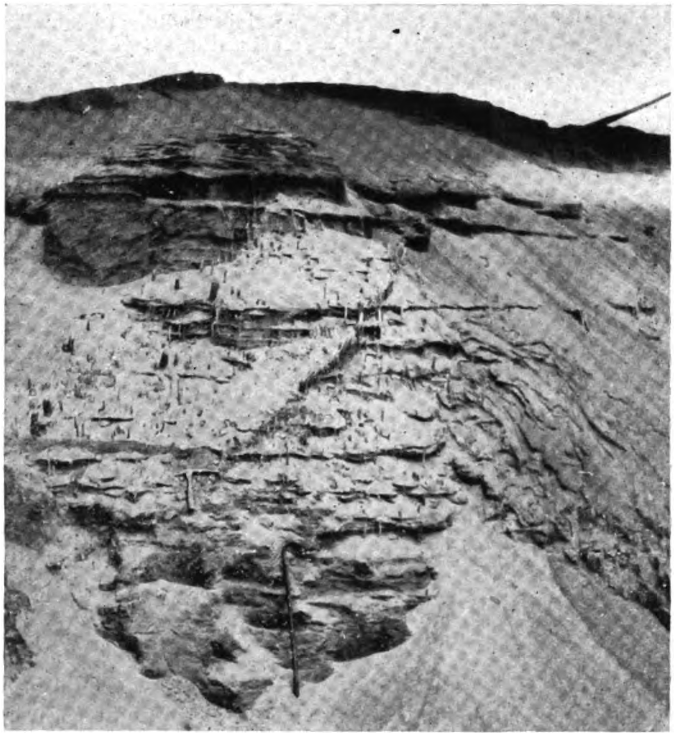


Fig. 19—Calcareous concretions in sand, Glenburnie, Frontenac county.

five, and between lots 30 and 35, township of Kingston, and are 20 to 30 feet deep. The three principal pits have areas of 100 by 150, 200 by 400, and 200 by 600 feet. The whole deposit is about 1,000 feet wide in a north and south direction, and more than 2,000 feet east and west. The sand is sharp and intermixed with small angular gravel of granitic nature. The upper part of the sand is brown for about 2 feet and shows some bonding power; below this part the colour becomes paler, and the greater part of the deposits consists of white sand. This sand contains quartz, feldspar and black mica among its grains, and some calcareous white concretions produced by the circulation of calcareous waters (fig. 19).

[1] 25th Annual Report, Part III, Ont. Bur. of Mines, 1916, The Geology of Kingston and Vicinity, p. 35.

These concretions are more abundant near the water level at the bottom of the pits.

Granular metric analysis of Glenburnie sand:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	1.55	2.40	2.80	3.85	5.70	37.95	77.30	90.95	98.45

Per cent. of fineness, 64.34.

Real specific gravity	2.700	Weight in lbs. per cubic foot ...	96.60
Apparent specific gravity	1.546	Percentage of voids	42.8

N.B.—The largest grains contain calcareous concretions.

The sand is hauled to Kingston in wagons drawn by four horses or by steam tractors. As the cost of transportation is high, it sells delivered at $1.40 per cu. yard. It is used principally for building purposes, but also for core-making at the locomotive works in Kingston.

Robert Harpell, Cataraqui.—On lot 16, concession three, Kingston township. This sand pit is part of a farm of 100 acres owned by Mr. Rixbridge, 4 miles northwest from Kingston. This sand sells at 40 cents a load of 3 cubic yards in the pit, or at $5.00 for a similar load delivered in Kingston.

Big Sandy Bay, Wolfe Island.—A little of this sand is brought by boats to Kingston; it is sharp, and suited for building purposes. It is proposed to load this sand by pumping it directly in the scows which bring it to Kingston.

Glengarry County

In the township of Kenyon, forming the northwest part of this county, there are some sand and gravel pits round Alexandria, Maxville and Dunvegan (fig. 20).

Most of the material is coarse gravel used for road work, and is not always of first quality. The gravel is very coarse, principally near the top, and contains many boulders, sometimes larger than one foot in diameter. In some pits more than 50 per cent. of the pebbles should be rejected on account of their size. Near the bottom the fragments are smaller, and the material may become a pea gravel or a coarse sand. The pebbles are mostly angular; from 70 to 90 per cent. are of limestone, but the gravel, considered as a whole, is rather sandy, and 50 per cent. of sand is not rare. The depth varies little from one pit to another. 12 feet being a good average. This material is sold as low as 10 cents a cubic yard. A list giving the names of the owners, location and size of the principal pits and their annual output follows:—

No.	Owner	Township, Con. and Lot	Size in feet	Output	Remarks
1	McKinnon, Alexandria ...	Lochiel III, 37 ..	75 by 50 by 12	....	Ridge 200 by 300 ft. in area.
2	Wm. Metcalfe, Greenfield	Kenyon IX.	100 by 100 by 12	3,000 yds.	Reserves 500 by 100 by 12 ft.
3	Campbell, Dunvegan	Kenyon VIII, 17 (W½)	50 by 30 by 5	60 loads ..	Reserves 75 by 75 by 10 ft.
4	McLeod, Dunvegan	Kenyon IX, 19	90 by 30 by 4 50 by 15 by 8	....	Two pits about 100 yards apart.
5	Hugh McIntosh, Dunvegan	Kenyon IX, 21 ..	100 by 75 by 10	100 yds.	Reserves 50,000 cubic yds.
6	D. Kennedy, Maxville	Kenyon VIII, 36.	60 by 60 by 20	....	Reserves 25,000 cubic yds.
7	N. K. McLeod, Maxville......	Kenyon VIII. 35.	60 by 15 by 4	....	....

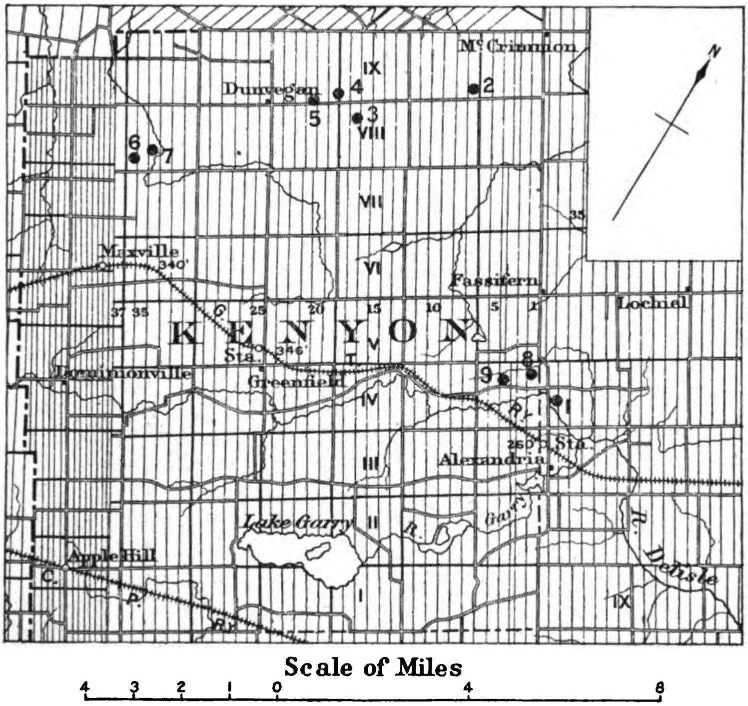


Fig. 20—Map of the township of Kenyon, Glengarry county, showing principal sand and gravel deposits. The numbers refer to the list given in the text.

Granular metric analysis of gravel in Wm. Metcalfe's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	82.65[1]	90.70	93.45	95.45	96.75	99.20	99.70	99.80	99.90

Percentage of fineness, 4.71.

[1] The 82.65 per cent. remaining on the 4-mesh sieve is made up of 54.65 per cent. larger than 1-inch pebbles and 28.00 per cent. between 1-inch and .185-inch.

Some of these gravel pits contain sand layers, and this is the case in the Kennedy pit, Maxville. At the bottom of this pit there are two feet of sharp black sand, very good for building purposes. Most of this sand is made of limestone grains.

Granular metric analysis of sand from D. Kennedy's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	6.80	14.30	21.65	58.35	85.25	97.95	98.70	98.80	98.90

Per cent. of fineness	35.5	Weight in lbs. per cubic foot ...	106.60
Real specific gravity	2.722	Percentage of voids	37.3
Apparent specific gravity	1.706		

Nap. Gauthier's Sand Pit, Alexandria (*No.* 8).—On lot 1, concession four, Kenyon township.—Excavation about 150 by 50 by 5 feet. The pit is not worked at present. The sand is fine and loamy near the top, and becomes coarser at the bottom. It is part of a ridge extending about a mile in an east and west direction and forming a watershed. Some sand of this formation was used for moulding purposes by the shell works in Alexandria.

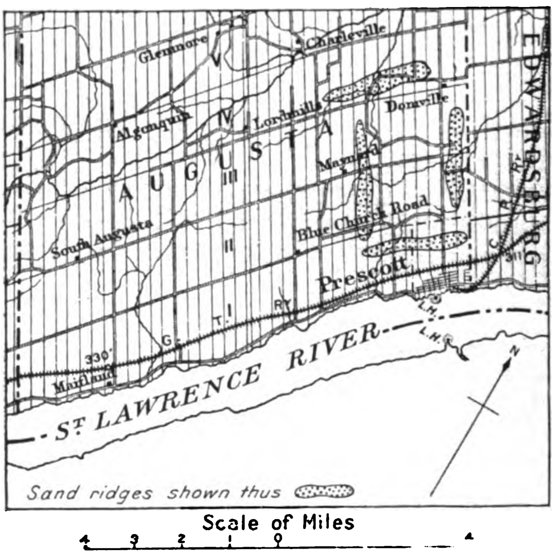


Fig. 21—Sand ridges north of Prescott, Grenville county.

McDonald's Sand Pit, near Alexandria (*No.* 9).—On the east half of lot 4, concession four, Kenyon. This belongs to the same formation as the preceding pit, and contains sand and gravel.

Grenville County

The deposits of sand north of Prescott belong to four ridges of sand dunes extending over concessions one, two and three, (fig. 21). Those dunes are advancing.

The length of the ridges is about one mile, with an average height of 15 feet and an average width of 250 feet. In concession one, this sand ridge

is about half a mile north of the Grand Trunk railway. It has a northwest direction, and extends over the cemetery and Prescott fair grounds. The sand is used for building. The excavations are generally refilled with sand a few days after they are opened. This sand is delivered in the town of Prescott for $1.00 a load of 1.5 cubic yards. There are two similar sand ridges but with a north and south direction, running through concession two, on both sides of the road to Domville. A fourth ridge with an east-west direction is located in concession four, on the grounds belonging to John Fell.

There is an important gravel ridge west of the sand dunes. The general direction of this ridge is N.30°E. Several pits have been opened, the average depth being 10 feet. The gravel contains a good proportion of sand; the pebbles range between 2 and 8 inches, in some places being very angular. About 50 per cent. consist of limestone, the remainder being eruptive and metamorphic rocks. This material is generally sold at 25 cents a yard at the pit. The following list gives the location, size and output of some of these gravel pits:

Owner	Township, Con., Lot	Size in feet	Output	Remarks
Corporation of Prescott	Augusta I, 8.	200 by 200 by 12	....	Reserve: 1 acre.
Sterritt, Prescott	Augusta II, 10.	100 by 100 by 10	200 yd.	Pebbles smaller than in other pits.
Geo. W. Robinson, Prescott......	Augusta II, 9.	200 by 200 by 10	....	Reserve in sight: 300,000 cu. yds.
Wm. Robinson, Prescott......	Augusta III 8.	....	small	Large quantities available.

Granular metric analysis of gravel from Sterritt's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	77.00[1]	81.05	83.40	88.90	92.45	96.95	98.15	98.70	99.40

Percentage of fineness, 9.33.

Grey County

The deposits of sand and gravel in this county are few in number. The writer examined a few small sand pits near Meaford. Most of the area between Meaford and Owen Sound is occupied by limestone and glacial deposits.

The Sydenham river at Owen Sound runs through a very deep and steep valley, with three different terraces. Sand and clay are found on each of them. A hole dug in one of the streets of Owen Sound, near the river, shows 1 foot soil, followed by 5 feet of sand overlying clay. There is a large sand pit south of the town on the slope of the second terrace. The excavation made on the side of the hill is about 70 feet high and yields sand for building purposes. South of Owen Sound, at Inglis falls, there is some sand and gravel.

[1] Of the 77 per cent. remaining on the 4-mesh sieve, 52.35 per cent. were pebbles larger than 1 inch in diameter, and 24.65 pebbles smaller than 1 inch.

R. Smith's Sand Pit, Inglis Falls.—On lot 9, concession two, Derby township. The pit is about 100 feet in diameter and 25 feet deep. From testings the sand is known to extend 25 feet deeper. The deposit covers about 2½ acres, making an available reserve of about 200,000 cubic yards. In this pit there are alternate layers of gravel for rough-casting, filtering sand and plastering sand. Near this pit is another containing only gravel. The output in 1916, when the pits were owned by Mr. Neelands, was about 300 yards. Selling prices were 15 cents a yard for road gravel taken at the pit and $1.20 a yard for filtering sand delivered at the filtering plant of Owen Sound, located about one mile from the pit. Rockford station on the Owen Sound branch of the C. P. R. is about one mile east of the pit.

Granular metric analysis of plastering sand, R. Smith's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.30	0.80	1.35	3.90	11.80	71.00	91.65	95.85	98.20

Per cent. of fineness 58.35
Real specific gravity 2.732
Apparent specific gravity 1.575
Weight in lbs. per cubic foot.... 98.412
Percentage of voids 42.3

Granular metric analysis of filtering sand, R. Smith's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.65	3.05	7.95	36.60	60.60	90.90	97.20	98.50	99.35

Per cent. of fineness 45.02
Real specific gravity 2.687
Apparent specific gravity 1.539
Weight in lbs. per cubic foot 96.163
Percentage of voids 42.7

Haldimand County

There is a good sand beach near Port Maitland, on the shore of Lake Erie, at the mouth of the Grand river. The deposits are in the form of sand dunes extending for two miles along the lake shore and 300 to 500 feet inland. The deposit is from 12 to 15 feet thick and overlies the limestone. There are various grades of sands and gravels in the dunes. Near the surface the material is generally blown sand that could perhaps be used as an abrasive for cutting stones. Under one foot of this material the sand is coarser, and is used for building purposes. It passes gradually into a limestone gravel before the solid rock is reached. Dredging of gravel and sand is done in the river by a pumping dredge; Jos. Battle of Thorold operated such a dredge during 1916.

Numerous deposits of sand and gravel occur near the Grand river in the northwestern part of this county (fig. 22). They are mostly round Caledonia and seem to be ancient river terraces. The gravels are principally composed of pebbles, but contain a little shale. The sands are generally sharp and of good quality for building purposes.

Fig. 22—Map showing sand and gravel pits along the Grand river, Haldimand county. The numbers refer to the list given in the text. No. 8 is the location of the Oneida Lime Co's. quarry.

The following list gives some information about the principal pits:

No.	Owner	Township	Size in feet	Product	Remarks
1	F. W. Foster, Caledonia	Oneida	60 by 60 by 7	Sand	Reserve: 4 acres, 2½ ft. of loam on top.
2	Isaac Gowland, York	Seneca	20 deep	Gravel	Idle; 5 ft. clay on top.
3	Robert Hamilton, Caledonia	Seneca	200 by 200 by 5	Gravel	Reserve: 10 acres, idle.
4	George Moore, Caledonia	Oneida	100 by 100 by 20	Gravel and sand	Only 1 ft. to be stripped.
5	Nicholas, Gideon, Caledonia	Oneida	....	Sand	Not working.
6	Arthur Smith, Caledonia	Oneida (Tiffany Block)	80 by 80 by 10	Sand 150 yd. per annum	Reserve: 5 acres. Sold at 40 cents a yd.
7	David Young, Caledonia	Seneca	2acres 10ft. deep	Gravel	Not working.

Oneida Lime Co., Limited.—An interesting deposit is the one worked by this company in Cayuga township, near Nelles Corners. The headquarters of the company are in Buffalo. This company quarries Oriskany sandstone of Devonian age, and by crushing this material obtains a very pure white sand used for glass making. After washing, this sand contains sometimes as much as 99.50 per cent. of pure silica. The works have been operating six years. The quarry in 1917 measured 300 by 100 by 12 feet. There is an old quarry to the west of the present one of double the size.

The Oriskany sandstone appears to form a small basin overlying the Salina limestone beds of Silurian age and covered by the Onondaga limestone. At the quarry the section is as follows:

Brown soil	4 to 6 inches.
Coarse sandstone	4 "
White and fine sandstone	3 feet.
Coarse sandstone	4 inches.
Ferruginous sandstone	6 "
Quartzitic sandstone	6 feet.
Dolomitic limestone	

The rock varies in grain and nature in a vertical as well as in a horizontal direction. At some places, the sandstone can be crushed to sand between the fingers; at other places, it is much more like a quartzite.

The Oneida Lime Co., Ltd., owns about 150 acres. To the east of its property and on the same outcrop, there is another property, 200 acres in size, belonging to the Consolidated Plate Glass Co.

The material from the quarry is washed and crushed to a coarse sand, composed principally of small grains, but containing also some fragments up to 8 mm. in diameter. In this state the sand is suitable for use in steel plants. To produce glass sand, the crushed material is passed through an 8-mesh screen and the oversize is recrushed. There were about 25 employees working for the greater part of the year. Some material is shipped during winter months from storage bins. The output for 1916 was about 15,000 tons and sold at $1.50 to $1.70 a ton.

Granular metric analysis of glass-making sand, Grade No. 6, The Oneida Lime Co.:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.00	1.20	2.50	7.60	17.70	64.80	93.60	98.15	99.40

Per cent. of fineness	57.23	Apparent specific gravity	1.64
Coefficient of uniformity	75.90	Weight in lbs. per cubic foot	102.474
Real specific gravity	2.612	Percentage of voids	37.2

Two analyses made at the Babcock Testing Laboratory, Buffalo, of crushed sandstone from this quarry follow:

	Old Quarry.	New Quarry.
Moisture	0.00	0.00
Loss on ignition	0.93	0.13
Iron (metallic?)	1.63	1.48
Al_2O_3	trace	trace
CaO	1.55	0.71
MgO	0.30	trace
S	0.11	0.08
SiO_2 (by difference)	95.48	97.60
Total	100.00	100.00

It is probable that the iron considered as metallic is in the form of magnetite (Fe_3O_4).

Following is a chemical analysis of this sand, ready for glass works, by W. K. McNeill:—

	Per cent.		Per cent.
Silica	96.54	Alkalies	0.94
Alumina	0.96	Carbon dioxide	0.59
Ferric oxide	trace	Water	0.15
Ferrous oxide	nil		
Lime	0.90		100.08

The figures of the three analyses are very similar, and confirm the value of this material for chemical industries. This sand would be suitable for the manufacture of silica brick. Similar materials are used for such purposes in France. From a recent note of M. Philippon [1] the following results are taken:

(1) The crushing strength of the bricks after drying and burning is greater the more finely the quartz grains are pulverized.

(2) All the quartz tested will give strong bricks if it is sufficiently pulverized.

(3) The swelling or expansion on burning of the brick made of similar grains is greater when the grains are large. The expansion is practically nil for impalpable powders.

(4) The strength of the brick after drying and burning is greater as the amount of water introduced into the paste is increased.

(5) The strength of the brick after drying depends on the amount of lime added to the quartz. The strength of the brick after burning increases up to 1 per cent. of lime, remains constant between 1 and 2 per cent., and seems to decrease for more than 2 per cent.

(6) Every unit of lime added to the quartz reduces the melting point by about 20° C.

Bricks made from impalpable powder begin to harden at 800° C.

At 1,200° C. their crushing strength is about 2,700 lbs. per square inch; at 1,300° C. it is about 4,000 lbs. per square inch. Bricks made from coarser grains begin to harden only at 1,100° C. At 1,300° C. their crushing strength is only 1,000 lbs. per square inch.

The less fusible bricks are those containing the minimum of impalpable material. In a good brick the grains should not be larger than 8 mm. in diameter.

[1] La fabrication des briques de silice. Compte Rendus des séances de l'Académie des Sciences, Paris, Tome 165, No. 25, December 17th, 1917, pp. 1002-1005.

In practice silica bricks should be made from pulverized silica containing at least 96 per cent. SiO_2. Crushed Oriskany sandstone is of such a standard composition. In France silica bricks are made from a mixture of 30 per cent. impalpable powder, and 70 per cent. silica grains ⅛ mm. in diameter. The impalpable powder contains about ·2 per cent. lime, the remainder being silica. The total amount of lime in the brick is thus not higher than 0.6 per cent. These bricks are burned at 1,300°C. in a tunnel kiln. They have a crushing strength of 2,800 to 3,500 lbs. per square inch. The average expansion on burning is 1.6 per cent. The absolute specific gravity is lower than 2.4, the apparent specific gravity being about 1.9. The melting point is near 1780°C. Such bricks have lasted for more than 200 runs in a Martin furnace. They are in general use in steel plants and foundries.

Physical properties of sand, grade No. 7, from Port Maitland beach, Haldimand county:

Granular metric analysis:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0	0	0	traces	0.10	10.90	83.55	97.65	99.55

Per cent. of fineness	67.58	Apparent specific gravity	1.62
Coefficient of uniformity	86.85	Weight in lbs. per cubic foot ..	101.224
Real specific gravity	2.834	Percentage of voids	42.5

Haliburton County

The Irondale, Bancroft and Ottawa railway runs through the southwest corner of Haliburton following a series of lakes and the Irondale river, a tributary of the Burnt river. In this part of the county limestone hills rise often very steeply, but in the immediate neighbourhood of the shore lines there is an alluvial plain made of sand and silt. The sand is generally ferruginous, and contains limestone and feldspar fragments. The proportion of quartz is occasionally very small. The deposits extend sometimes for miles, although they are not wider than 300 yards. In some places the pebbles become more abundant, and the material could be used for building purposes, as ballast for railroads and for road work.

Snowdon Township

In the southwestern corner of Snowdon township, there is an area covered by an apron of sand 10 to 15 feet thick and sometimes 60 feet higher than the level of the Burnt river at Kinmount. The road marking the boundary between Haliburton and Peterborough runs for about three miles through this sandy terrace, under which appear gneissoid rocks with numerous veins of pegmatite. A similar apron of sand and gravel lies along the tracks of the Grand Trunk railway, Haliburton branch, principally near the station of Gelert. North of Gelert it is seen in several road and railway cuttings, the thickness of the deposits being at some places 40 feet.

Dysart Township

In the township of Dysart a large sand and gravel pit was excavated on lot 13, concession seven, west of the railway, the material being principally used for ballast and road work. The pit is of two parts, the first being 200 by 20 by 6 yards, the second 200 by 30 by 10 yards in size. The total material removed amounts to nearly 100,000 cubic yards. The pit is not worked at present, but a reserve of 100,000 cubic yards is still available. This pit is about one and a half miles south of the town of Haliburton. On lot 14, concession seven, south of the railway, there is a smaller pit, 200 by 100 by 30 feet in size, producing sand and gravel. The deposits round the lakes at Haliburton form a sand terrace about 40 feet above the water level. The sand is ferruginous, and may be used for road and building purposes. To the north of Haliburton, small local deposits resulting from the weathering of the underlying granitic gneiss are sometimes met. Such is the case about one mile and a half north of Haliburton along the road to Moose lake. A small deposit of ferruginous sand mixed with stones was worked here and used for re-filling the adjoining road. The deposit is about 90 feet above water level at Haliburton, and the excavation 75 by 30 by 4 feet in size.

Special reference should be made here to a particular industry developed in Haliburton by Bollender Bros. Crystalline limestone is quarried about one mile east of Haliburton, on the north shore of the river, on lot 19, concession eight, of Dysart. The rock is a white dolomitic limestone, very crystalline and containing in parts numerous grains of chondrodite altering to serpentine, and small flakes of a blue greenish phlogopite. Mr. Bollender gave us the following analysis of this material:

	Per cent.
$CaCo_3$	50
$MgCo_3$	5
Impurities	5

The excavation is at present 40 by 20 by 6 yards. The work started in 1914. The rock is quarried in lumps about 6 inches in diameter and sent to the mill where it is crushed to ⅛-inch and screened to five different grades. The product is used as poultry grit, as stone dust or agricultural lime, and for mixing with cement (aggregates, plastering, floors, artificial stone, etc.), for filtering basins, and for washing compounds. The tonnage shipped in 1917 amounted to 500 tons, the average price being $4 a ton for crushed material. Some part of this production goes to the western provinces. The several grades are screened as follows:

Below 60-mesh: Fine dust used for washing compounds.
From 60-mesh to 10-mesh: Agricultural lime, mixing with cement, etc.
From 10-mesh to 8-mesh: Grit for birds and young chickens.
From 8-mesh to 5-mesh: Grit for pigeons.
From 5-mesh to ⅛ in.: Poultry grit.

Halton County

There are no deposits of importance along the shore of Lake Ontario, in this county, but in the northeastern corner of the county, round Glen Williams and Georgetown, some sand and gravel are available.

North of Glen Williams there is a sandy hill about 75 feet high and 125 feet wide where it crosses the road. This hill extends for several hundred yards on either side of the road, and contains deposits of both sand and gravel. A sand pit has been opened on the side of the hill on the property of Jos. Beaumont of Glen Williams. Only a few loads were sold in the last few years. A small gravel pit has also been opened up from which material has been taken for road work.

With regard to gravel, the most important pits lie round Georgetown. Sand beds of small thickness occur occasionally in these deposits. The gravel is rather coarse near the top, and becomes finer in the central part of the bed. It is made up of pebbles of different size and shape, mostly limestone, but there are also some pebbles of sandstone, shale, granite, and quartz. These gravels make very good material for road purposes; certain grades are self-cementing. The gravel is generally sold at 25 cents a load of 1.5 cubic yards. The various pits are indicated in the following list:

Owner	Township, Con. and Lot	Size in feet	Output per year	Remarks
Jas. Arnott, Georgetown...	Esquesing tp. Con. VII., lot 17	....	....	6 ft. loam to strip.
J. A. Willoughby, Georgetown...	Esquesing tp. Con. VII., lot 17(W½)	150 by 100 by 25.	2,400 yd.	0–5 ft. to strip. Reserve, 3 ac.
James Buck, Georgetown...	Esquesing tp., Con. VII., lot 18	100 by 40 by 20.	150 yd.	Reserve, ½ ac. Idle in 1917.
John Giffen, Georgetown...	Esquesing tp., Con. VIII.....	100 by 100 by 60.	....	Alternate layers of gravel and sand.

The physical properties of sand from J. Beaumont's pit, Glen Williams, are shown by the granular metric analysis, as follows:

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.30	0.90	1.45	5.75	11.30	49.90	85.25	94.15	98.60

Per cent. of fineness	61.38	Apparent specific gravity	1.67
Coefficient of uniformity	73.95	Weight in lbs. per cubic foot ..	104.348
Grade	No. 6	Percentage of voids	39.6
Real specific gravity	2.766		

Granular metric analysis of gravel from J. Buck's pit, Georgetown:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	51.55[1]	65.70	75.20	91.80	96.35	99.15	99.50	99.60	99.75

Per cent. of fineness, 13.5

[1] The 51.55 per cent. remaining on the 4-mesh sieve consists of 31.40 per cent. pebbles larger than one inch, and 20.15 per cent. smaller than one inch. Some pebbles are made of cemented grains.

Hastings County

Deposits of sand and gravel are scarce in this county. There are some deposits near Belleville, but along the Bay of Quinte there is practically no gravel, nor any sand east of Belleville, before reaching Quinte point, 14 miles from the city and 8 miles west of Deseronto. The greater part of the shore of the Bay of Quinte is marked by limestone outcrops. There is a deposit of gravel west of the Prince Edward bridge, largely used for the supply of Belleville.

John Creeper's Pit.—John Creeper, Belleville, owns some sand and gravel pits situated east of the road to Madoc, in the eleventh concession of Thurlow township, just one-quarter of a mile from the limit of Belleville. These pits supply a dozen different kinds of sand and gravel. Two pits are now working, the northern one producing principally gravel, the southern pit chiefly sand. The northern pit is at present 150 by 90 by 10 feet. The deposit is principally composed of limestone pebbles, which are generally flat and angular. It looks like the upper portion of a limestone formation crumbled to pieces. Different beds

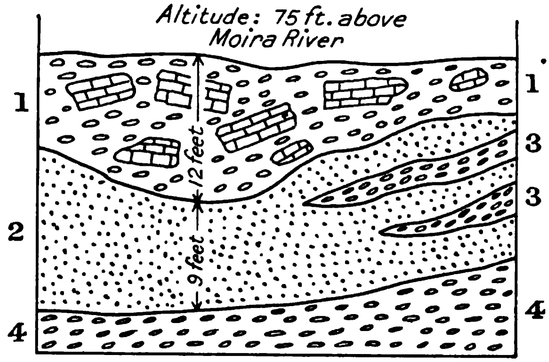


Fig. 23—Section of John Creeper's sand and gravel pit. (1) Gravel, with limestone boulders. (2) Sand. (3) Black limestone gravel layers. (4) Gravel.

are to be found in the gravel, some being more shaly and dark in colour, the others composed of limestone only. In one of the walls an anticline was very well marked. Very few granitic pebbles are to be found in the gravel, which consists mostly of material in place. The walls of the pit are vertical and hold very well. The gravel is used for road and concrete work.

The southern pit is located near the highest point of the hill, about 75 feet above the level of the Moira river, where the limestone outcrops. At present the size of the excavation is 600 by 120 by 25 feet, the longer dimension being east and west, while the depth increases to the east. The section is shown in the accompanying diagram (fig. 23). The upper part is composed of gravel with very large flat limestone boulders sometimes one yard long. Some of the pebbles are, however, of igneous rocks. The wall of the pit is about 25 feet high and stands perfectly straight. The gravel at the top is kept together by some calcareous sand and is used for making concrete. Beneath the gravel is a bed of sand eight feet thick, which is used for mortar.

Under the sand comes some black gravel which is believed to be of considerable depth. The sand is a mixture of quartz grains and calcareous material in the form of calcite and limestone grains. The calcareous nature of this sand is shown by the following chemical analysis by W. K. McNeill.

	Per cent.		Per cent.
Silica	55.46	Potash	2.04
Alumina	9.99	Soda	2.62
Ferric oxide	0.81	Carbon dioxide	11.04
Ferrous oxide	1.58	Water	0.43
Lime	14.88		
Magnesia	1.29	Total	100.14

Fig. 24.—Shallow excavation in cemented material, J. Creeper's sand and gravel pit.

Norm calculated from the preceding analysis:

Calcite	25.10	Magnetite	1.16
Orthoclase	11.68	Enstatite	3.20
Albite	22.01	Grünerite	2.24
Anorthite	4.17	Quartz	28.02
Corundum	2.04	Water	0.43
		Total	100.05

The outstanding feature of this norm is the very low content of quartz. The feldspars seem to be more abundant than one would conclude from a casual examination of the material. The large percentage of calcite explains the auto-cementing properties of this sand.

The physical properties of the sand are shown by the granular metric analysis:

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.00	0.10	0.40	4.20	13.90	60.70	86.05	93.25	98.00

Per cent. of fineness 60.38
Coefficient of uniformity 72.15
Grade .... No. 6
Real specific gravity 2.788
Apparent specific gravity 1.70
Weight in lbs. per cubic foot ...106.223
Percentage of voids 39.0

Granular metric analysis of gravel from Creeper's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	49.80	63.85	69.50	79.10	85.55	94.45	97.55	98.55	99.30

Per cent. of fineness, 18.04.

Near Corbyville, on the eastern shore of the Moira river, on lot 6 in the fourth concession of Thurlow, a deposit of sand overlies the clay. There is about one foot of loam, then some ferruginous sand, and beneath sharp white sand. The sand is very pure, and could perhaps be used for glass-making. The property is owned by Wilson Reid.

Hungerford Township

In the township of Hungerford, deposits of sand and gravel are found in the neighbourhood of Tweed. At the northeastern end of Stoco lake, small sand deposits resulting from the weathering of granitic rocks outcropping in this area are found near the lake shore. Small sand beaches are also noticed in little bays of the lake. On lot 17, concession ten, a large sand ridge about 100 yards wide and 500 yards long extends in a southwest and northeast direction. It contains large and valuable reserves of sand for building purposes, and lies about 25 feet above the lake level. This ridge represents an old beach of Stoco lake.

On the south and western shores of Stoco lake, along the road running from Chapman to Tweed, there are several sand and gravel ridges, sometimes 100 feet above the present level of the lake. One of the ridges is located just north of Chapman, on lot 8, concession seven. A pit on this ridge supplies mostly sand, although there is also some gravel. The excavation is 60 by 20 by 10 yards. On lot 9, concession eight, a gravel pit 50 by 50 by 25 yards in size has been opened; it is located two miles south of Tweed, the gravel being mostly used for road work. Another pit on lot 10, concession nine, is one mile south of Tweed and also supplies road material. The excavation is 100 by 30 by 12 yards.

In the western part of Tweed, there is a gravel and sand ridge on the farm of W. H. Hicks. A pit 100 by 40 by 20 yards in size supplies coarse sand for building purposes and road gravel. About three miles west of Tweed there are two small gravel pits on Geo. Graham's farm, lot 3, concession eleven, township of Hungerford. Reserves are very large, but the output in 1917 was only 150 loads sold at 10 cents per load.

In the northern part of Hungerford township the country is composed of Archean rocks covered by a mantle of earth and boulders. At some places it becomes very sandy, and between Tweed and Actinolite, for instance, large areas have been covered by sand brought in by the Moira and Scootamatta rivers. Some parts of the river banks present fine sand beaches. There is in this part of Hastings a large reserve of available material, the sand being generally coarse and fit for building purposes. It contains as a rule a large amount of limestone and granitic detritus, calcite, feldspar and kaolinite being common components. This is probably the reason why crops do well on these sandy areas.

Elzevir Township

At Actinolite, in the township of Elzevir, there is a big gravel pit about 100 by 50 by 15 yards in size, the products being largely used for road work.

Between Actinolite and Queensboro, some terraces noticed along the railway are sandy, and great reserves of ferruginous sand derived from the alteration of the country rocks are available. At the lower levels more gravel is mixed with the sand, and some gravel pits have been opened in the deposits near mile 45 of the Bay of Quinte railway, close to Queensboro and Allan stations, the latter place being located in Madoc township.

Madoc Township

Similar deposits are found in the township of Madoc, at some bends of the river south of Bannockburn. The sand often contains a large amount of lime and iron, and is brown in colour. A terrace about 25 feet above the present level of the Moira river is indicated by a large deposit of sand, at least 10 feet thick, covering several acres and located on lot 24, concession five, Charles White's farm. This sand contains a large proportion of calcite grains. However, as a whole, the area around Bannockburn is rocky, and arenaceous deposits are scarce. Similar conditions prevail in Tudor and Limerick townships.

Dungannon Township

It is only near Turiff, in Dungannon township, that gravel and sandy material appear over the area made up of limestone and amphibolites. This locality is in the drainage area of the Ottawa river. The sand found here is the product of decay of the neighbouring massive rocks, and was sorted by the rivers and lakes of the country in the earlier stages of their history. It contains as a rule a large amount of lime and some silt. The stratification is often oblique. The occurrences are local, but near the Bay of Quinte railway sometimes extend over large areas. Good examples of such deposits are to be seen near Bancroft and L'Amable station. One pit is located 200 yards east of the York river at Bancroft,

on the south side of the road to Bronson, lot 63 of the gore of Faraday township. The excavation is 30 by 10 by 7 yards in size, and supplies sand and gravel. Other areas along the York river and its tributaries are covered by drift of a sandy nature, this being the case between Bronson and the bridge on the York river, along the road running east from Bancroft; and in the area northwest of Bancroft along the York river and Baptiste lake. In this northern part of Hastings, the Archean rocks appear mostly as rounded hills, the slopes near rivers and lakes being often covered by sand, gravel, silt or clay.

Huron County

The sand and gravel beach at Kincardine in Bruce county extends to the south in Huron county as far as Goderich. In the remainder of the county, sand is comparatively rare, but there are many gravel pits in the townships of Hay, Usborne and Stephen, near Crediton, Dashwood, Exeter, Hensall and Zurich. Most of these deposits are connected with the shore line of the ancient Lake Algonquin. Sometimes the bottom of the pit is of sand. The gravel is often variable in the same deposit. At the top it is generally very coarse, with some pebbles as large as 10 inches in diameter, but the regular gravel of this county is made of angular pebbles not larger than 3 inches. Finer grades such as pea gravel are found sometimes near the bottom. As to its composition, the gravel is mostly made up of limestone pebbles intermixed with sandy material. The coarse gravel is used for road making, and is sold at about 10 to 15 cents a yard, while finer cement gravel is sold at 25 to 30 cents a yard. Following is a list of the principal gravel pits in the region round Exeter and Crediton:

Owner	Township, Con. and Lot	Size in feet	Output	Remarks
Ed. Campbell. Exeter	Usborne, near N.E. corner, Con. VI	....	....	Not working.
John Cann, Exeter	Usborne, Con. V, lot 31	50 by 50 by 30	....	Not working, sand and gravel.
Wm. Moody, Exeter	Usborne, Con. II	....	....	Large pit.
Wm. J. Robinson, Crediton	Stephen, Con. III. lots 4, 5	200 by 60 by 16	1,000 yd.	Reserve, 1 ac.
John Rollins, Crediton	Stephen, Con. V, lot 8	125 by 75 by 6	1,000 yd.	
Peter Whitlock, Hensall	Usborne, Con. V, lot 30	3 pits about 50 by 50 by 30	....	
John Wood, Exeter	Usborne, Con. IV–V	600 by 300 by 12	1,500 yd.	Reserve, 8 ac., gravel and sand.

Granular metric analysis of sand in J. Cann's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained	8.85	33.10	48.10	66.45	72.85	87.80	96.50	98.45	99.35

Per cent. of fineness	32.06	Apparent specific gravity	1.85
Coefficient of uniformity	39.25	Weight in lbs. per cubic foot	115.60
Grade	No. 2	Percentage of voids	31.90
Real specific gravity	2.718		

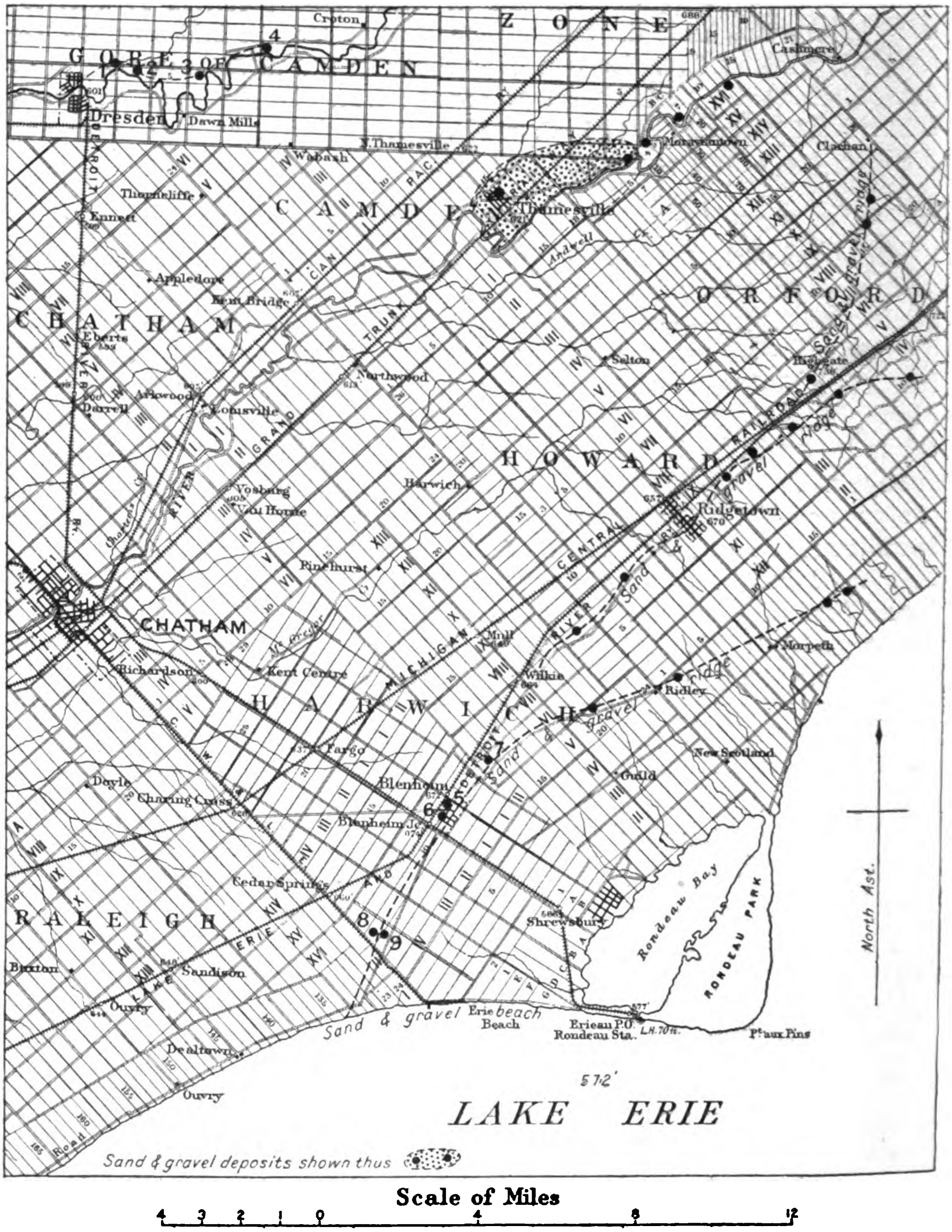


Fig. 25—Map of the eastern part of Kent county, indicating location of sand and gravel deposits. The numbers refer to the list given in the text.

Kent County[1]

In this county sand and gravel (fig. 25) are found as recent deposits along the Lake Erie shore, principally at the southwestern end of the county, in the township of Romney, and also in Harwich township, near Rondeau Park. A sandy and gravel beach 30 to 40 feet wide is met south of Cedar Springs and extends as far as Erieau and Rondeau Park. There is a clay dike north of the beach, parallel to the lake shore. At Erieau the beach is 100 yards wide and about 150 yards at the eastern end near the harbour. The sand is coarse; near the water there is a strip about 4 feet wide of limestone pebbles one and two inches in diameter. Dredging was done on this part of the shore, but has been discontinued.

Other recent deposits are found along the Thames river in Camden township and near the Sydenham river, in the Gore of Camden. The deposits along the Thames occur principally around Thamesville, and are due to floodings in this flat region. In this area, extending to the northeast as far as Moraviantown, the principal gravel pits are those owned by Arthur Tiffin and Mrs. Wm. Watts. The pit of Mrs. W. M. Sherman, in Thamesville, is a sand pit. The sand is pure and coarse. The gravels of this area are generally fine and made of limestone pebbles. The sand is sold at about 25 cents a yard, the gravel at 75 cents. At the top of these recent deposits of sand there is sometimes a small layer of moulding sand. Such is the case at Arthur Tiffin's pit, where at places this layer is two feet thick.

The recent deposits near the Sydenham river are located around Dresden. They are generally of coarse sand containing some pebbles, and are used for cement work. There is here also some moulding sand at the top of the deposits.

Herewith are particulars of the pits about Thamesville and Dresden:

No.	Owner	Township and Con. and Lot	Size in feet	Output	Remarks
1, 2	Rice, Geo. A. and Sons, Dresden	Gore of Camden, Con. III and IV, lot 5	60 by 60 by 8	140 yd.	3 ft. earth at the top, some moulding sand.
3	——Sharp, Dresden..........	Gore of Camden, Con. VI, lots 4 and 5	100 by 100 by 10	......	South shore of river.
4	——Richards, Dresden	Gore of Camden	....	......	Not working.
	Arthur Tiffin, Thamesville	Camden, Con. X, lot 6	300 by 100 by 7	......	2 ft. of soil on top.
	Mrs. Wm. Sherman, Thamesville	Camden	200 by 100 by 10	......	2½ ft. to strip. Reserve 2 ac.
	Wm. Watts, Thamesville	Camden	300 by 75 by 8	......	Large reserve.

Besides the recent deposits there is an extensive sand and gravel ridge running from Lake Erie, about south of Cedar Springs, in a northeasterly direction, and passing through Blenheim, Wilkie, Ridgetown, Highgate, and Clachan, thus extending over the townships of Harwich, Howard and Orford. East of Blenheim the ridge subdivides into two branches, the southern one passing through Ridley, Morpeth and Palmyra. The ridge is of variable width and depth; it has its largest

[1] For further details respecting road material in the county of Kent, see L. Reinecke's Report, op. cit., pp. 115-137.

width, 600 ft., at the southwestern end near the lake shore; the depth varies between 5 ft. and 60 ft. The material comprises different grades of sand and coarse gravel. In the following table are given some details of the principal pits visited.

No.	Owner	Township, Con. and Lot	Size in ft.	Output	Remarks
5	—— Blenheim	Harwich, Con. I, lot 10.	150 by 75 by 7	......	Sand pit.
6	Ross, Blenheim	Harwich, Con. I, lot 11.	100 by 60 by 6	......	Gravel of fine grade.
7	Young, Blenheim	Harwich. Con. II, lot 10.	....	......	Worked out.
8	Wallaceburg, Chatham and Lake Erie Ry. Co.	Raleigh, Con. II, lot 24	500 by 150 by 30	......	Coarse and pea limestone gravel. sandstone and a little shale.
9	Townships of Raleigh and Harwich	Raleigh, Con. II, lot 24	75 by 75 by 30	......	Fine gravel, some iron oxide.

Granular metric analysis of sand, Geo. Rice and Sons, Dresden:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	1.75	12.00	21.00	38.80	45.75	63.20	88.50	95.85	98.10

Per cent. of fineness	48.34	Apparent specific gravity	1.65
Coefficient of uniformity	42.75	Weight in lbs. per cubic foot	103.10
Grade	No. 6	Percentage of voids: Calculated	36.0
Real specific gravity	2.578	Measured	34.5

Granular metric analysis of sand from Arthur Tiffin's pit, Thamesville:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	2.40	4.45	5.85	9.70	12.50	34.10	82.65	91.45	95.95

Per cent. of fineness	62.33	Apparent specific gravity	1.66
Coefficient of uniformity	70.15	Weight in lbs. per cubic foot	103.72
Grade	No. 6	Percentage of voids	39.60
Real specific gravity	2.748		

Lambton County

A line of deposits (fig. 26) passing through Copleston, north of Petrolia, Wyoming, north of Watford, and bending then slowly to the north, while passing through the counties of Middlesex and Huron, runs about parallel with the present shore of Lake Huron at an average distance of ten miles. These deposits are probably connected with an old shore line of Lake Algonquin. Numerous pits have

been opened at the several places mentioned, as the deposit extends over a large area and contains great reserves of sand and gravel. The ridge is sometimes wider than 1,000 feet, and in this county alone from the Copleston area east, it runs for more than twenty miles. It supplies good building sand, cement gravel and road gravel. Gravel is the predominant material, and this consists principally of limestone; around Petrolia and Copleston there is very little slate among the pebbles, but in some places, as at Watford, the quantity of limestone becomes smaller, and most of the pebbles are shale in a state of alteration to clay and iron oxide. When used

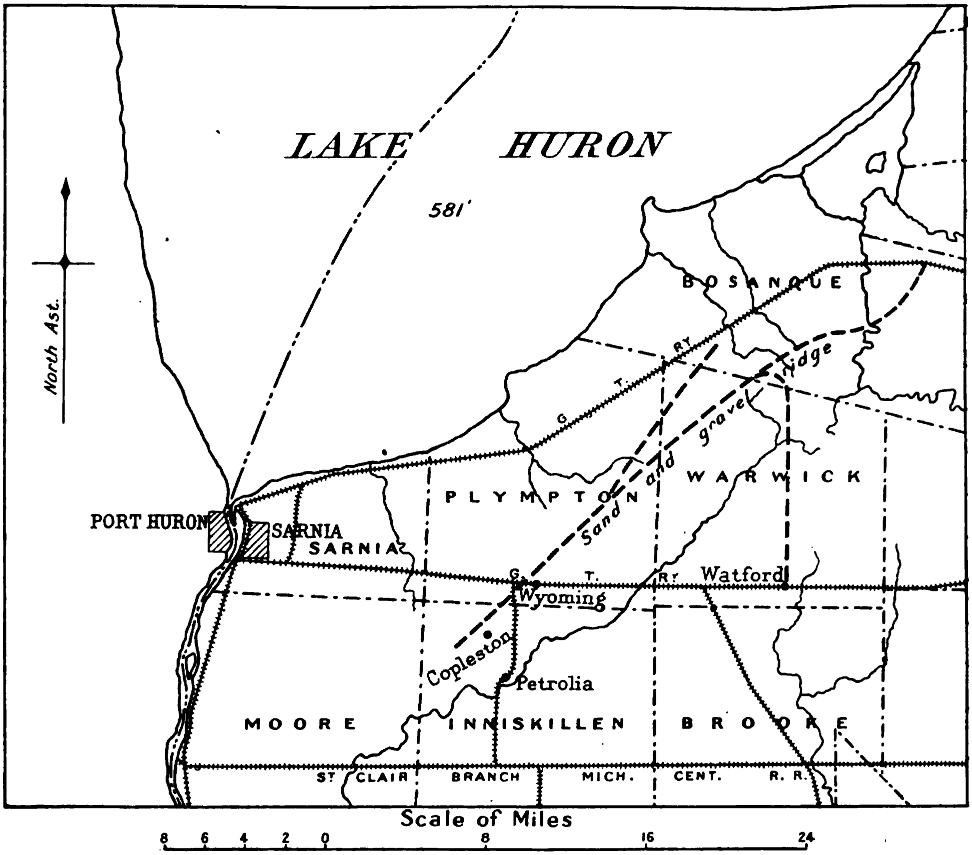


Fig. 26—Northern part of Lambton county, showing the location of the sand and gravel ridge passing near Copleston, Wyoming and Watford.

on roads such gravel produces a large amount of fine dust. The poor quality of such road gravel explains why it is sold at 16 cents a yard in the pits near Watford, while at Copleston the average price is 50 cents a yard. The working of the pits is very often done in a wasteful way, 3 or 4 feet generally remaining unworked at the bottom of the pit. The teamsters loading the gravel in a pit prefer to take the upper layers, as they are much more easily shovelled into their wagons; or they take only the very best material, that of inferior quality being disregarded and covered by loam and earth.

The following list gives some details about the deposits connected with the shore line of the ancient lake Algonquin:—

Owner	Township, Con. and Lot	Size in ft.	Output	Remarks
John W. Cann, Copleston	Enniskillen, Con. XIII, lot 7.	150 by 150 by 7	200 yd.	Cement gravel, ferruginous at the bottom. Reserve 2 acres.
Enniskillen tp., Petrolia.	Enniskillen, Con. XIII.	300 by 150 by 10	1,000 yd.	Sand and gravel. Reserve 2 acres.
Estate, J. Kerr, Petrolia.	Enniskillen, Con. XIII, lot 9.	300 by 200 by 10	....	Sand and cement gravel. Reserve 1.5 acre.
John Kerr, Petrolia	Enniskillen, Con. XIII, lot 13.	150 by 150 by 15	2,000 yd.	Sand and gravel. Reserve 0.5 acre.
Robert Kettle, Petrolia..	Enniskillen, Con. XIII, lots 7 & 9	Two pits, 60 by 60 by 10, 300 by 150 by 8.	500 yd.	Sand and gravel 23 ft. deep. Reserve 20 ac.
Wm. Kettle, Petrolia....	Enniskillen, Con. XIII.	325 by 100 by 12	500 yd.	Sand and gravel. Reserve 10 acres.
Jno. McPhedran, Petrolia	Enniskillen, Con. XIII.	300 by 300 by 10	....	Sand and gravel. Reserve small.
Robt. Whiting, Copleston.	Enniskillen, Con. XIII, lot 13.	400 by 150 by 8	1,000 yd.	Cement gravel. Reserve 1.5 acre.
Jno. Wooley, Petrolia....	Enniskillen, Con. XIII, lot 7.	500 by 125 by 6	....	Gravel of variable grade, 12 ft. deep. Reserve 1.5 acre.
Richard Bryson, Wyoming	Plympton, Con. V, lot 18.	100 by 100 by 12	200 yd.	Gravel and sand.
Thos. Conboy, Wyoming..	Plympton, Con. V, lot 17.	10 deep.........	....	Gravel. Reserve 1.5 ac.
Corporation of Wyoming.	Plympton, Con. I, lot 16.	200 by 100 by 6	....	Gravel.
G. T. R., Wyoming......	Plympton, Con. I, lot 16.	400 by 200 by 10	....	Gravel.
Lucas, Wyoming........	Plympton, Con. V, lot 18.	200 by 100 by 10	750 yd.	Cement and road gravel, and sand.
Isaac Mariett & Son, Wyoming.	Plympton, Con. V, lot 18.	400 by 125 by 7	....	Not worked.
Stonehouse, Wyoming....	Plympton, Con. I, lot 15.	1 acre by 15 ft..	750 yd.	Road gravel.
Robt. Fleming, Watford..	Warwick, Con. IV, lot 17.	600 by 150 by 4	250 yd.	Cement gravel. Reserve 1 acre.
Robt. Lucas, Watford....	Brooke, Con. XII, lot 12.	300 by 150 by 12	300 yd	Road gravel. Reserve 3 acres.

Granular metric analysis of sand from R. Kettle's pit, Copleston:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	1.30	2.80	6.15	8.95	43.80	86.10	93.85	98.40

Per cent. of fineness	62.07	Apparent specific gravity	1.62
Coefficient of uniformity	77.15	Weight in lbs. per cubic foot...	101.22
Grade	No. 6	Percentage of voids	40.8
Real specific gravity	2.738		

Granular metric analysis of gravel from R. Kettle's pit, Copleston:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	57.15	62.35	63.75	66.10	68.15	89.15	97.95	98.70	99.30

Per cent. of fineness, 21.93.

Other deposits of sand and gravel occur in the county of Lambton. Ten miles north of Wyoming, there is a gravel beach along the shore of Lake Huron. In the township of Euphemia, there are some pits round Aberfeldy and others near Cairo. The walls of these pits are made of alternate layers of gravel and sand. This material is sold at 75 cents a yard in the pit. There are only two pits working at present:—

Owner	Township, Con. and Lot	Size in feet	Out-put	Remarks
Samuel Turtle, Aberfeldy.....	Euphemia, Con. IV, lot 26.	200 by 100 by 12	600yd.	The gravel does not contain pebbles larger than 2 in. Reserve: 60 acs.
John L. Munroe, Cairo	Euphemia.	250 by 75 by 8	......	Fine gravel and sand. Reserve: 1.5 acs.

Lanark County

There is some gravel near Smiths Falls which was extensively used by the railway companies for ballast. Near Perth, there is some sand and gravel.

The deposit used by the Canadian Northern Railway company, two miles north of Smiths Falls, in the township of Montague, extends over about 20 acres, with an average depth of 10 feet. It was worked by steam shovel, and about half of the gravel has been taken out.

The gravel pit owned by George Kerfoot, Smiths Falls, is in the township of Montague, lot 26, concession eight. It is about 3.5 miles north from Smiths Falls, near the tracks of the Canadian Pacific railway. The average depth of the pit is 10 feet, below which clay is found. The material is about two parts of gravel to one of sand. Two hundred cubic yards were taken out in 1916, and sold for delivery in town at $1.75 per cubic yard. There is an estimated reserve of three acres.

Leeds County

Deposits of sand and gravel in this county are scarce. Some sand and gravel used by the corporation of Brockville is obtained from the St. Lawrence river, about ten miles west of the city. It is supplied by J. H. Simpson, Lyn.

As to pit material, one deposit is owned by Geo. E. Sherwood, Prescott Road, Brockville, situated in Elizabethtown township, lot 3, concession one. The present excavation is 200 by 100 by 10 feet. The material consists principally of gravel, with some sand. The pebbles are angular, and are generally dolomitic limestones or metamorphosed rocks; this gravel is used for concrete work. The

sand contains a little loam, but by sifting a good sharp building sand is obtained. The output of 1916 was 500 cubic yards, sold at $1.25 a cubic yard for delivery in Brockville. The available reserve extends over six acres.

Jos. H. Morrison, Brockville, owns a deposit of sand and gravel near Lyn, in Elizabethtown township. The reserve extends over three acres, and the present pit is 25 feet deep. The output of 1916 was about 800 cubic yards, sold at $1.75 for delivery in Brockville.

Some moulding sand occurs in a sand pit two and a half miles west of Brockville. It is owned by T. H. Bresee and is situated on lot 20, concession one, Elizabethtown. The moulding sand extends here over a large area, covered by bushes. Trenches were dug at 4 feet depth and an average thickness of 2 feet of moulding sand was discovered. Three hundred tons of this sand are used in one year by foundries in Brockville and Smiths Falls, replacing an equal quantity of Albany moulding sand. Below is given a chemical analysis of this material by W. K. McNeill, Provincial Assayer.

Moulding sand, Bresee farm, near Brockville:—

	Per cent.		Per cent.
Silica	74.80	Soda	3.43
Alumina	11.25	Carbon dioxide	0.60
Ferric oxide	2.11	Water	0.62
Lime	2.92	Ferrous oxide	1.89
Magnesia	0.41		
Potash	2.20	Total	100.23

The alumina and alkalies are probably the result of the disintegration of feldspars, and the iron oxides are due to the alteration of ferro-magnesian minerals.

Norm calculated from the preceding analysis:—

Calcite		1.40
Orthoclase	2.79	50.78 feldspars
Albite	28.82	
Anorthite	9.17	
Magnetite		3.02
Wollastonite		0.58
Enstatite		1.00
Grünerite		1.72
Quartz		41.05
Water		0.62
Total		100.17

The large proportion of feldspars and quartz indicates that this sand is one of the final stages of the weathering of a granitic rock. The bonding power is due to a certain amount of kaolinite and ferric hydroxide not indicated in the norm.

At the opposite or southwestern end of the county, there is a deposit of sand on a granite hill, two miles north of Gananoque. A pit owned by Fred C. Gray, of Gananoque, is located on this hill, in lot 11, concession one of the township of Leeds. The size of the pit is about 120 by 120 by 15 ft. Most of this material is fine sand derived from granitic minerals, and some pebbles. There are two feet of moulding sand near the top. The total average output is 3,000 yards a year. It is sold at 25 cents a cubic yard at the pit and $1.25 for delivery in Gananoque. The reserve is 15 acres. There is a small gravel pit, about 200 yards southwest from the sandpit.

In the township of South Elmsley, in the northern corner of the county, there is some good gravel. One pit located in lot 10, concession three, is operated by James Shanks, Smiths Falls. The present excavation is 100 by 100 by 8 feet, the bottom being limestone. About 70 per cent. of the material is gravel, the remainder being sand. The gravel is coarse and is used for road-making. The pebbles vary between four inches and one quarter of an inch in diameter. They consist mostly of limestone, with some granitic and metamorphic rocks.

Granular metric analysis of sand from James Shanks' pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained ..	20.00	22.90	25.20	37.50	52.55	93.45	97.80	98.30	98.95

Per cent. of fineness	39.26	Apparent specific gravity	1.77
Coefficient of uniformity	55.95	Weight in lbs. per cubic foot ..	110.60
Grade	No. 5	Percentage of voids	35.10
Real specific gravity	2.729		

Granular metric analysis of coarse sand from Fred C. Gray's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.40	1.20	1.85	5.55	18.45	75.05	93.50	97.30	98.90

Per cent. of fineness	56.42	Apparent specific gravity	1.67
Coefficient of uniformity	75.05	Weight in lbs. per cubic foot ..	104.35
Grade	No. 6	Percentage of voids	40.50
Real specific gravity	2.807		

Granular metric analysis of fine sand from Fred C. Gray's pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.00	0.00	0.00	traces	0.10	24.60	76.20	90.60	98.05

Per cent. of fineness	67.83	Apparent specific gravity	1.64
Coefficient of uniformity	76.10	Weight in lbs. per cubic foot ..	102.47
Grade	No. 6	Percentage of voids	41.80
Real specific gravity	2.822		

Lennox and Addington County

The area round Napanee in the townships of Richmond and Fredericksburg is made of slaty limestones of the Trenton formation. About ten miles south of Napanee this slaty limestone occurs as an escarpment along the shore of Lake Ontario. The weathering and disintegration of the rock produces a limestone gravel, made of discoid pebbles of greatly varying sizes, from a few millimetres up to one foot in diameter. The deposit of gravel is only two or three feet thick, and occurs very often on a width of ten yards along the escarpment. Some large boulders of gneiss and granite occur along the lake shore, and pebbles of this material are found in small quantity in the gravel. The gravel is used for road work in the vicinity of the lake shore.

On the Napanee River

Northeast of Napanee, the Napanee river runs through a valley containing numerous alluvial deposits of sand and gravel. This river comes from Frontenac county, enters the township of Camden, and passes through Colebrook, Yarker, Camden East, Newburgh, Strathcona and Napanee, this last town being in the township of Richmond. On both sides of the river slowly grading slopes are covered by alluvial deposits until 100 feet above the river level. At this line begins a nearly vertical escarpment of limestone. The sand is coarse and makes good material for building purposes. It contains pebbles of limestone, and of granitic or gneissoid rocks coming from the eastern pre-Cambrian area. Large boulders are also found in these deposits.

Good deposits of this kind occur east of the bridge on the Napanee river, about half-way between Napanee and Newburgh. A pit of 60 by 30 by 12 feet is opened south of the Napanee-Newburgh road in the township of Camden, on lot 5, concession one. It belongs to David Mowears, the deposit extending over three acres of his property. The sand layers show oblique stratification. The material is used for building purposes and for road work and is sold at 25 cents a load.

The largest sandpit south of the river was the one operated by R. C. Katon, township of Camden, lot 6, concession one, but it is not worked at present. Another pit south of the river belongs to M. Emptey, township of Camden, lots 8 and 9, concession one.

On the northern shore of the Napanee river, east of Strathcona, and about one mile west of Newburgh station, there is a large alluvial deposit of sand and gravel with some silt. It has been used for a length of 500 yards by the Canadian Northern railway for ballast. The width of the pit is from 60 to 75 yards, and the average depth 10 yards. The material removed amounts thus to nearly 500 by 70 by 10 = 350,000 cubic yards. Large reserves are still available. The material is more silty and not so suitable for building purposes as the one found on the south shore.

Another large pit is located 200 yards east of the Newburgh graveyard, between the Napanee-Yarker road and the river. Sand and gravel are found in this pit, the material being of good quality. It is worked on a length of 150 yards in a direction parallel to the river, an average width of 25 yards, and an average depth of six yards. The upper part is as a rule of sharp sand, with very few pebbles; the lower part is gravel, the two parts being sometimes separated by a thin layer of clay. The whole deposit shows oblique stratification.

In Camden East, Sidney Williams opened a sand pit on the north shore of the river. The material is used for building purposes. This pit is 125 yards long and 8 yards deep, and is located between the C.N.R. tracks and the graveyard.

The area along the C.N.R. between Camden East and Tamworth is mostly covered with limestone boulders and some granitic material. In the cuttings between Enterprise and Tamworth, several local deposits of gravel produced by the disintegration of the underlying rocks are noticeable.

Sheffield Township

In the township of Sheffield, some deposits occur in the area around Tamworth. North of the station of Erinsville, about two miles west of Tamworth, a gravel and sand ridge occurs on the west shore of Beaver lake. One pit of 150 by 75 by 30 feet has been opened by P. McCann, in the township of Sheffield, on lot 8, concession three. Most of this material is the product of decomposition of granite, metamorphic schists, and limestone. Large pebbles and boulders of these rocks are found in the deposit. The sand is coarse and suitable for building purposes, but the market is small and very little is taken out in a year; the selling price is 15 cents per load. Another gravel pit, belonging to Mr. Anderson, Erinsville, is located on the north shore of the C.N.R. Little work has been done in it lately.

About one mile and a quarter west of Erinsville, near the boundary between the counties of Lennox and Addington and Hastings, there is a very large gravel pit belonging to the C.N.R. and used for ballast supply. The pit is not worked at present, but the excavation is 300 by 100 by 20 yards in size, representing a removal of 600,000 cubic yards. The reserve contains at least 1,200,000 cubic yards. The pit is located on lot 5, concession two, Sheffield, north of the C.N.R. tracks. The gravel exhibits oblique stratification. On top of the ridge the material is a little silty.

The area between Beaver lake and White lake is near the contact of granitic and sedimentary rocks. It is covered by numerous drumloid hills made of sand and gravel. Similar hills occur east of Beaver lake, and in one of them is situated a pit owned by H. Cunningham, Tamworth. It produces sand and gravel, the former coarse, the latter made up of pebbles of various rocks, rather angular in shape. The excavation is small: 30 by 15 by 4 feet, but there are large reserves available. The material is used for road work and building purposes, road gravel being sold at 10 cents per load.

Similar deposits occur in the township of Kaladar, near Addington and Kaladar.

Lincoln County

In this county the shore line of the glacial lake Iroquois extends from Queenston, at the east, to Grimsby, at the west, passing through St. David, Homer, St. Catharines, Jordan, and Beamsville. It lies between the Niagara escarpment and the Lake Ontario shore, but is not marked by a continuous line of sand and gravel deposits. Only some small bars occur here and there along this line, as at Homer and St. Catharines, but they are without economic importance.

White sandstone, which may be suitable for making glass or ferro-silicon, has been found under the red Medina sandstone on the Niagara escarpment. Outcrops of this white sandstone may be seen along the Michigan Central railway northeast of St. David. It consists of layers about 10 inches thick, alternating with small bands of shale. Above the railway the white rock outcrops for about 15 feet underlying, in succession upwards, 8 feet of red sandstone, 3 feet of bluish calcareous shale, and the dolomitic limestone of the top. Assuming that the white sandstone runs one mile in length along the railway with a probable thickness of

12 feet, each yard under the plateau would represent a reserve of 2,000 by 4 = 8,000 cubic yards. Below is given a chemical analysis of this white sandstone by W. K. McNeill:—

White sandstone, Queenston Quarry Co., St. David:—

	Per cent.
Silica	93.36
Alumina	2.54
Ferric oxide	0.75
Ferrous oxide	1.13
Lime	0.90
Alkalies	0.83
Magnesia	0.37
Carbon dioxide	0.22
Water	0.23
Total	100.33

Norm calculated from the preceding analysis:—

Calcite		0.50	
Orthoclase	2.78		8.98 feldspars
Albite	3.14		
Anorthite	3.06		
Corundum		0.31	
Enstatite		0.90	
Grünerite		1.45	
Magnetite		1.16	
Quartz		86.88	
Water		0.23	
Total		100.41	

The proportion of quartz in this rock is very high, contrasting with the small amount of feldspars and of iron-bearing minerals.

Middlesex County

Deposits of gravel are very abundant in this county; sand also occurs, but in smaller amount. The principal locations are: London, Thorndale, Dorchester, Lucan, and Parkhill. In the last locality the deposits belong to the old shore line of lake Algonquin; in the other localities they are connected with the history of the Thames river and its tributaries.

In the city of London large quantities of gravel are taken from the north branch of the river; most of this gravel is washed from the gravel banks west of Adelaide street. On the south branch there are only small deposits, and on the main stream there is nothing of interest above the cove, west of the G.T.R. bridge. The principal deposits in the river and pits of sand and gravel are marked on a map of London (fig. 27). The pits are numerous; practically the whole north-western part of the city is on gravel, while in the eastern and northeastern parts the sub-soil is all sand. Sewer excavations at 20 feet in depth in Egerton street have shown the sand at the bottom. The upper parts are generally of good sharp building sand, while the deeper parts become finer and approach quicksand. The gravels vary in size of pebbles from one pit to another, affording supplies of road and cement gravel. The pebbles are mostly of limestone fragments intermixed with some igneous and metamorphic rocks. This material is delivered in various wards at prices varying from 50 cents to $1.25 a cubic yard. The city of London used in 1916 about 50,000 cubic yards of gravel. These figures were obtained from H. A. Brazier, city engineer.

Near Thorndale the gravel pits supply gravel of similar kind. About 80 per cent. is limestone, the pebbles being sometimes as large as four inches in diameter. This material is used for road building and is sold at 20 cents per cubic yard. Southwest of Thorndale there is an area of several square miles covered by such gravel.

At Dorchester, in the southeastern part of the county, the gravel is mixed with coarse and sharp sand, one-half of the material being gravel, the other half sand. Fifty per cent. of the pebbles are limestone. The deposit extends on both sides of the Thames river. There are several deposits of this kind between Dorchester and Sandpit, near London.

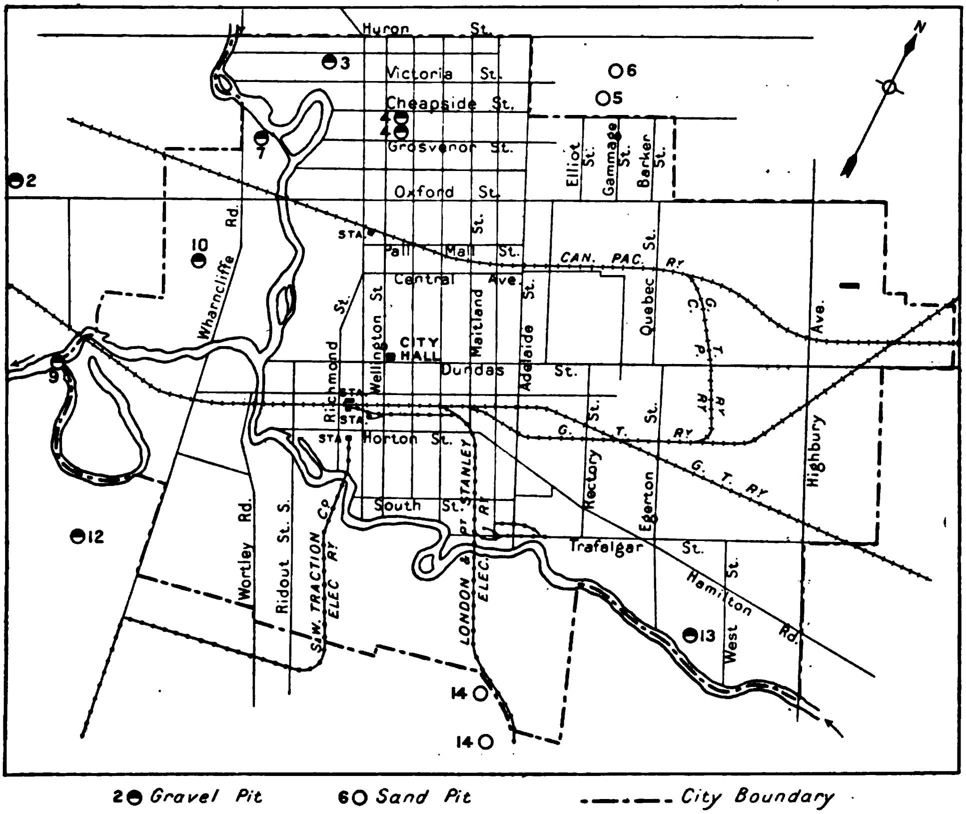


Fig. 27—City of London, Ont., with location of sand and gravel deposits. Scale: one mile to the inch. The numbers refer to the list given in the text.

In the township of Biddulph, in the north of the county, there are some gravel pits round Lucan and Clandeboye. The material is made of pebbles generally under 5 inches and coarser near the top.

The fine grade of the gravel found near the bottom of the pits is sometimes auto-cementing, and has some value as a cement gravel.

The deposits in the neighbourhood of Parkhill are numerous. They are located in the townships of West Williams, East Williams, and McGillivray. As to the quality, the ridge contains road and concrete gravel, the first being sold at 10 cents, the second at 25 cents a yard at the pit. The average depth of the deposits approaches 10 feet.

The following list gives some details about the principal pits in Middlesex county:—

No.	Owner	Location	Size in feet	Remarks
1	——, London....	North Branch of the Thames, between Oxford and Adelaide Sts., London..................	....	River gravel.
2	——, London....	Near Jewish Cemetery, north side of Oxford St., London...	150 by 75 by 10	Gravel pit. Double of actual area in reserve.
3	——, London....	Angle of Regent and Talbot Sts., London	150 by 60 by 4	Road gravel pit.
4	——, London....	Block between Cheapside, Wellington, Grosvenor, Waterloo Sts., London	20 deep	Gravel pit; quite exhausted
5	Builders' Supply Co., London	South of Eastern end of Victoria St., London............	300 by 150 by 15	Sand pit.
6	Boss, Lower London	North of eastern end Victoria St., London	100 by 100 by 15	Sand pit.
7	——, London....	Near river; angle of Beaufort St. and Wharncliffe Road, London	300 by 150 by 12 150 by 150 by 12	Two gravel pits. Similar area in reserve.
8	M. Stincombe, London	....	75 by 75 by 10	Gravel hill.
9	——, London....	Island at mouth of cove, Thames main branch, London........	250 by 50	Gravel.
10	——, London....	Paul St., London	....	Gravel.
11	——, London....	Outside and west of city; along Pipe Line Road.............	....	Gravel pits.
12	——, London....	West of Alexandra Ave. London	....	Gravel pit.
13	——, London....	Southeastern part Egerton St., London	....	Gravel pits.
14	——, London....	Near Base Line, Westminster tp., W. of London & Port Stanley Ry.	....	Two sand pits.
15	Mrs. Henderson, Thorndale	Nissouri, W. tp., Con. I, lot 15.	500 by 150 by 10	Road gravel. Res., 4 acres.
16	Walter Bryan, Thorndale	Nissouri, W. tp., Con. I, lot 16.	100 by 100 by 15	Road gravel. Res., 2 acres.
17	Henry Baskerville, Thorndale	Nissouri, W. tp., Con. III, lot 5.	300 by 300 by 10	Road gravel. Res., 2 acres.
18	Raywood Bott, Thorndale	Nissouri, W. tp., Con. V, lot 2..	100 by 100 by 15 100 by 100 by 15	Two gravel pits. Ridge, 500 yd. long and 100 yd. wide.
19	Wm. Smith, Thorndale	Nissouri, W. tp., Con. IV, lot 3.	150 by 150 by 12	Road and cement gravel. Reserve, 25 acres.
20	Geo. Showler, Dorchester	Dorchester, N. tp., Con. III, lot 4	300 by 150 by 6	Gravel and sand.
21	Michael Armitage, Lucan	Biddulph tp., Con. IV	Small	Gravel pit.
22	Geo. Hodgins, Lucan	Biddulph tp., Con. IV..........	Small	Gravel pit.
23	John S. Park, Lucan	Biddulph tp., Con. II, lot 30....	300 by 200 by 20	Road and cement gravel. Reserve, 4 acres.
24	T. Appleton, Parkhill........	McGillivray tp., Con. XIX, lot 10	100 by 100 by 12	Road and cement gravel.
25	Lewis H. Durr, Parkhill........	McGillivray tp., Con. XVIII....	300 by 200 by 6	Cement gravel. Reserve, 2.5 acres.
26	John Grieves, Parkhill........	East Williams tp., Con. VIII...	300 by 300 by 4	Cement gravel.
27	—— Hartle, Parkhill........	McGillivray tp., Con. XVIII..	200 by 50 by 10	Road and cement gravel.
28	Wm. Smithers, Parkhill........	McGillivray tp., Con. XIX, lot 10	250 by 40 by 12	Gravel and sand. Reserve, 3 acres.
29	Wesley Harris, Kerrwood	Adelaide tp., Con. IV, lot 1	200 by 150 by 20	Sand and gravel. Exhausted.
30	Waltham, Kerwood.	Adelaide tp., Con. IV, lot 2.....	300 by 300 by 20	Sand and gravel. Exhausted.
31	Rivers, Kerwood..	Adelaide tp., Con. III, lot. 1....	200 by 75 by 15	Road and cement gravel. Reserve, 1 acre. Output, 1,000 cu. yd.
32	Chambers, Kerrwood	Adelaide tp., Con. III, lot. 2....	225 by 175 by 30	Road gravel. Res., 10 acres.

Granular metric analysis of sand, Builders' Supply Co. pit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.50	4.55	10.50	29.15	45.55	92.55	99.90	100.00	100.00

Percent. of fineness 46.37
Coefficient of uniformity 63.40
Grade .... No. 5
Real specific gravity 2.718
Apparent specific gravity 1.65
Weight in lbs. per cubic foot .. 103.10
Percentage of voids 39.3

Granular metric analysis of gravel from fourth pit in list:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	96.25[1]	99.45	99.85	100.00	100.00	100.00	100.00	100.00	100.00

Per cent. of fineness, 0.49.

Muskoka District

In this district, where the rock formations are principally granitic, the gravels and sands are due to the weathering and to the glacial erosion of the rocks. In the southern part of the district along the Grand Trunk railway tracks, a fine, yellow and loamy sand appears as the result of the weathering. It is associated with gravel, of which large quantities are available round Bracebridge and Gravenhurst. Near the last-mentioned place, in the township of Muskoka, the deposits have been partially worked by the railway company. At Bracebridge, in Draper township, the two principal pits are located in the thirteenth concession, southeast of the town.

Ollivero's pit, on lot 4, is an excavation of 150 by 150 by 20 feet, with lenticular formations of sand and gravel. The material is sold at 10 to 20 cents a cubic yard.

John Watson's pit, on lot 5, is about 100 by 100 by 15 feet in size. It contains sand, cement, and road gravel, and also some big boulders near the top. The output in 1916 was about 150 cubic yards, and the selling price was about 10 cents a yard.

Granular metric analysis of sand from John Watson's pit, Bracebridge:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.40	3.50	9.50	29.45	46.45	75.90	90.55	95.05	98.40

Per cent. of fineness 50.09
Coefficient of uniformity 46.45
Grade .... No. 5
Real specific gravity 2.744
Apparent specific gravity 1.65
Weight in lbs. per cubic foot .. 103.10
Percentage of voids: Calculated 39.80
Measured. 35.70

[1] Of the 96.25 per cent. remaining on the 4-mesh sieve, 66.10 were pebbles larger than one inch.

More to the north, round Huntsville, in Chaffey township, several deposits of sand and gravel occur near the lake and river shores. At the locks of the Muskoka river, lot 13, concession twelve of Brunel township, there are large deposits extending about one mile south of the locks, on both sides of the river. The ridge is highest on the west side near the locks, where the deposit is 50 yards thick and 5,000 yards wide. The material is made up of sand of various grades and is used for building purposes and for road work.

At Fairyport, on the south shore of Fairy lake, lot 19, concession thirteen, there is a small sand beach and some sand banks about 30 feet above the lake level. Similar deposits occur in the neighbouring bay at Hollinshead's.

On the north shore of Peninsula lake some sand occurs in concession one of Chaffey township, between Deerhurst and Grassmere.

On the southwestern shore of Mary lake there are sand and gravel deposits around Port Sydney, in the township of Stephenson.

The northeastern shore of Lake Vernon is marked by some deposits of sand, gravel and clay, principally south of the mouth of the East river and also opposite May island.

All these arenaceous deposits in the Lake of Bays district are remnants of a former stage of the physical history of this area, when it was occupied by one large lake, the actual hills being small scattered islands.

Norfolk County

There is some sand and gravel available on the Lake Erie beach at Port Dover, west of the lighthouse overlying a substratum of clay, which rises in the form of cliffs along the beach. Near the shore are deposits of pea gravel, of blue and white limestone, also igneous and metamorphic rocks. The pebbles are less than half an inch in diameter, and are angular in shape. Beyond the gravel comes a zone of white or yellow, and farther up, near the clay cliffs, a red garnetiferous sand. Sometimes heavy winters with much wind and ice bring large deposits of gravel to the beach, this material being carted away in the spring. On this account there is often no gravel left on the beach in the summer. The gravel is sold at 15 cents a yard on the spot and $1.65 for delivery in town. There are large reserves of building sand to be found on the beach. Its only defect is a small proportion of vegetable matter.

In the corporation of Simcoe a deposit of sand about 10 acres in size has been worked by Arthur Coats. The size of the present excavation is 100 by 150 feet, with a depth varying from 6 to 20 feet. The upper part consists of two feet of soil, below this come 6 feet of good sharp sand, and then about 12 feet fine white sand. The sharp sand is sold at about $1.00 a cubic yard, for delivery in town.

There are valuable reserves of gravel between Simcoe and Watford, in the township of Townsend, but they are not being worked at present. To the south of Simcoe, there is a gravel pit in Charlotteville township, on lot 24, concession nine, belonging to Mr. Weston and Mrs. Wright. The excavation is 100 ft. by 500 feet by 8 feet. The material, coarse at the top, becomes finer near the bottom, and is made up principally of angular limestone pebbles. There is an approximate reserve of one acre of similar material. A bucket elevator, screens and bins represent the equipment in this pit.

To the southeast of Simcoe, in the township of Woodhouse, Mr. Decew owns a sand and gravel pit on lot 1, concession five, the present excavation being 120 by 120 by 10 feet, with an equal area in reserve. The output in 1916 was 2,000 yards, which sold at 50 cents per yard. A certain proportion of the sandy soil at the top of this deposit could be used as a pipe moulding sand.

Granular metric analysis of white beach sand, Port Dover:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0	0	tr	tr	tr	53.80	97.10	99.25	99.45

Per cent. of fineness	61.16	Apparent specific gravity	1.70
Coefficient of uniformity	97.10	Weight in lbs. per cubic foot	106.22
Grade	No. 6	Percentage of voids	43.60
Real specific gravity	3.017		

Granular metric analysis of red beach sand, Port Dover:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0	0	0	tr	tr	8.60	83.60	98.70	100.00

Per cent. of fineness	67.68	Apparent specific gravity	2.29
Coefficient of uniformity	90.10	Weight in lbs. per cubic foot	143.09
Grade	No. 7	Percentage of voids	44.40
Real specific gravity	4.123		

Northumberland County

The shore line of ancient Lake Iroquois crosses this county in a direction parallel to the shore line of Lake Ontario. Gravel and sand deposits are closely connected with the old shore line near Baltimore, Colborne, Brighton and Trenton. In the southeastern corner of the county, near Trenton, there are several beach levels with their related gravel and sand bars.

The gravel pits of the Baltimore and Cobourg Gravel Road Co. of Baltimore are situated one mile south of Baltimore, in the township of Hamilton, on lot 7, concession two. The principal pit is 150 by 150 by 15 feet in size, the material being gravel with a very small proportion of sand. The pebbles are 70 per cent. limestone, the remainder being metamorphic rocks. The upper part of the pit contains large boulders. There is a reserve of 3 acres of this material near the pit. The shore of Lake Ontario at Cobourg consists of sand of the same kind as the Port Hope sand. To the east of the town, the proportion of pebbles increases, and the shore line is marked out by gravel. Between Grafton and Colborne the country becomes sandy, and between Colborne and Brighton there are numerous sandy hills about one mile north from the shore of Lake Ontario. Small sand pits are located in these deposits.

Near Trenton large deposits of sand and gravel are worked in the Trenton mountain (fig. 28), a large hill west of the Trent river and south of the C. P. R. bridge, in Murray township, lots 4 and 5, concession one. The openings are on the side of the mountain, and afford a good section from north to south. The wall is about 150 feet high. At the top there is a layer of gravel from one to six feet thick; next, a sand layer about 15 feet in thickness, and under it about 80 feet of gravel of different sizes. There are some small layers of sand in this gravel; the stratification is horizontal in the main part of the section, but near

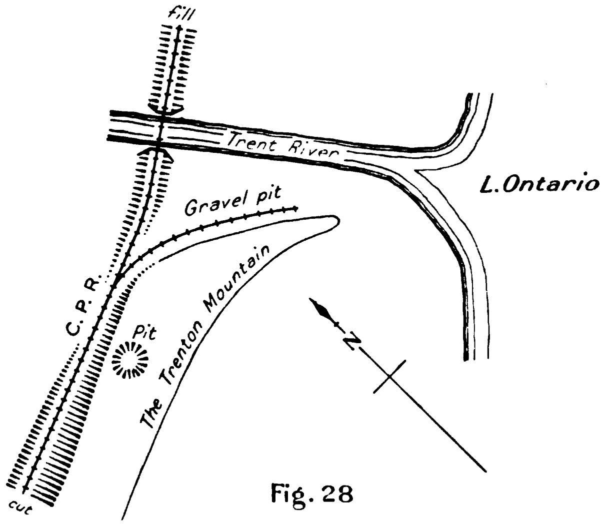


Fig. 28

Fig. 28—Location of the Trenton Mountain, Trenton.

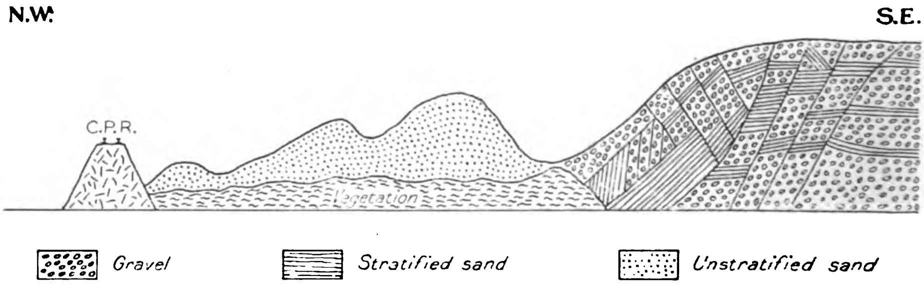


Fig. 29

Fig. 29—Diagram of section through the Trenton Mountain.

the northern end there has been some sliding, and several faults separate parts with different dips (fig. 29).

To the north, the formation becomes more sandy; the sand is mostly coarse and sharp, although there are some layers composed of a fine material with a large amount of silt. The coarse sand contains a good proportion of limestone grains, and shows some auto-cementing properties. The gravel is composed mostly of limestone pebbles, but includes also some metamorphic rocks and shales. The ridge of which the Trenton mountain is a part is about 150 yards wide to the south; it runs in a northwesterly direction, nearly parallel to the C. P. Ry. tracks.

A large cutting has been made for the railway roadbed in an east and west direction. Near the central part of this cutting, the ridge has a width of 500 yards. Several pits have been opened on top of the ridge.

Granular metric analysis of sharp sand at Trenton mountain:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	14.50	19.25	22.45	34.75	53.45	97.15	99.50	99.70	99.90

Per cent. of fineness	39.9	Apparent specific gravity	1.67
Coefficient of uniformity	62.40	Weight in lbs. per cubic foot	104.35
Grade	No. 5	Percentage of voids	42.50
Real specific gravity	2.908		

Granular metric analysis of fine silty sand at the Trenton mountain:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.00	0.00	0.10	1.50	4.00	9.95	11.30	13.20	33.40

Per cent. of fineness	91.8
Coefficient of uniformity	86.80
Grade	No. 9

Ontario County

Recent deposits of gravel and sand occur in small bays of Lake Ontario, near Whitby and Dunbarton. At Whitby the beach has been drawn on since 1913 to provide building materials for the Provincial Hospital for the Insane. The digging is carried on for eight months a year, with a weekly output of 175 cubic yards. The material is crushed and screened and gives sand, pea gravel with pebbles smaller than three-quarters of an inch, concrete gravel with pebbles from three-quarters of an inch to two inches, and road gravel, larger than two inches, the last being the remnant left from screening. The pebbles are principally of limestone, with a little granite, gneiss, quartzite, sandstone and about two per cent. of shale, the latter very objectionable. The sand is fine, and may be used for mortar, but is not quite sharp enough, and the presence of the shale dust also reduces its quality. Up to June, 1917, the beach had been excavated for a length of 700 feet, a width of 100 feet and a depth of 6 feet. The work is done with a steam shovel (fig. 30) and the yearly output is about 6,000 cubic yards. In the operations most of the western part of the beach has been removed.

There remains some material on the eastern shore of the bay and along the lake shore to the east. The formations near Whitby are mostly clay. Well-borings have discovered quicksand at 14 feet depth in some places, at 25 feet in others. Gravel was struck at a depth of 40 feet about one mile north of Whitby.

Sand pits belonging to Mr. Bonnell and to Mr. Broughton are located east of Whitby, the first at 1½ miles, the second at one-half mile. They supply good sharp sand for building purposes.

There is also a good gravel pit belonging to John Rice, located two miles north of Whitby.

At Dunbarton, the Lakeshore Sand and Gravel Co. is working on the material located in Frenchman bay, for the third season. The daily output is about 400 cubic yards, all brought by boat to Toronto: work is carried on in this plant for five days a week, and eight months a year, making a grand total of 68,000 cubic yards as the yearly output. Three kinds of material, sand, fine and coarse gravels are produced and used for building.

At Pickering on the G. T. Ry. all the sand and gravel used—about 200 cubic yards per year—is taken out of the creek after the spring floods.

Fig. 30—Steam shovel dredging gravel from Lake Ontario, Whitby.

Going north from the shore of Lake Ontario, the recent deposits become thinner, and the country north of the G. T. Ry. is made up mostly of Iroquois clay. Still farther to the north, one approaches the Iroquois sand and gravel ridge along which the Canadian Northern railway was built. This ridge runs in a northeasterly direction to the township of Pickering, passing through concessions one to five. At its western end near Cherrywood it is only three miles from Lake Ontario, but to the east, near Kinsale, it is seven miles north of the lake. The ridge then runs into the township of Whitby West and bends to the southeast, passing through concessions five, four and three, its general direction being from east to west through Whitby East in concession three. Near Taunton it is five miles north of the lake.

Sand and gravel deposits are quite continuous in this ridge through the whole of Ontario county. Numerous pits, most of them gravel pits, have been opened. The character of the gravel is quite uniform along the ridge in this county: the pebbles are subangular to rounded in shape, consisting of about 70 per cent. limestone and 30 per cent. granite and metamorphic rocks. At some places, as in

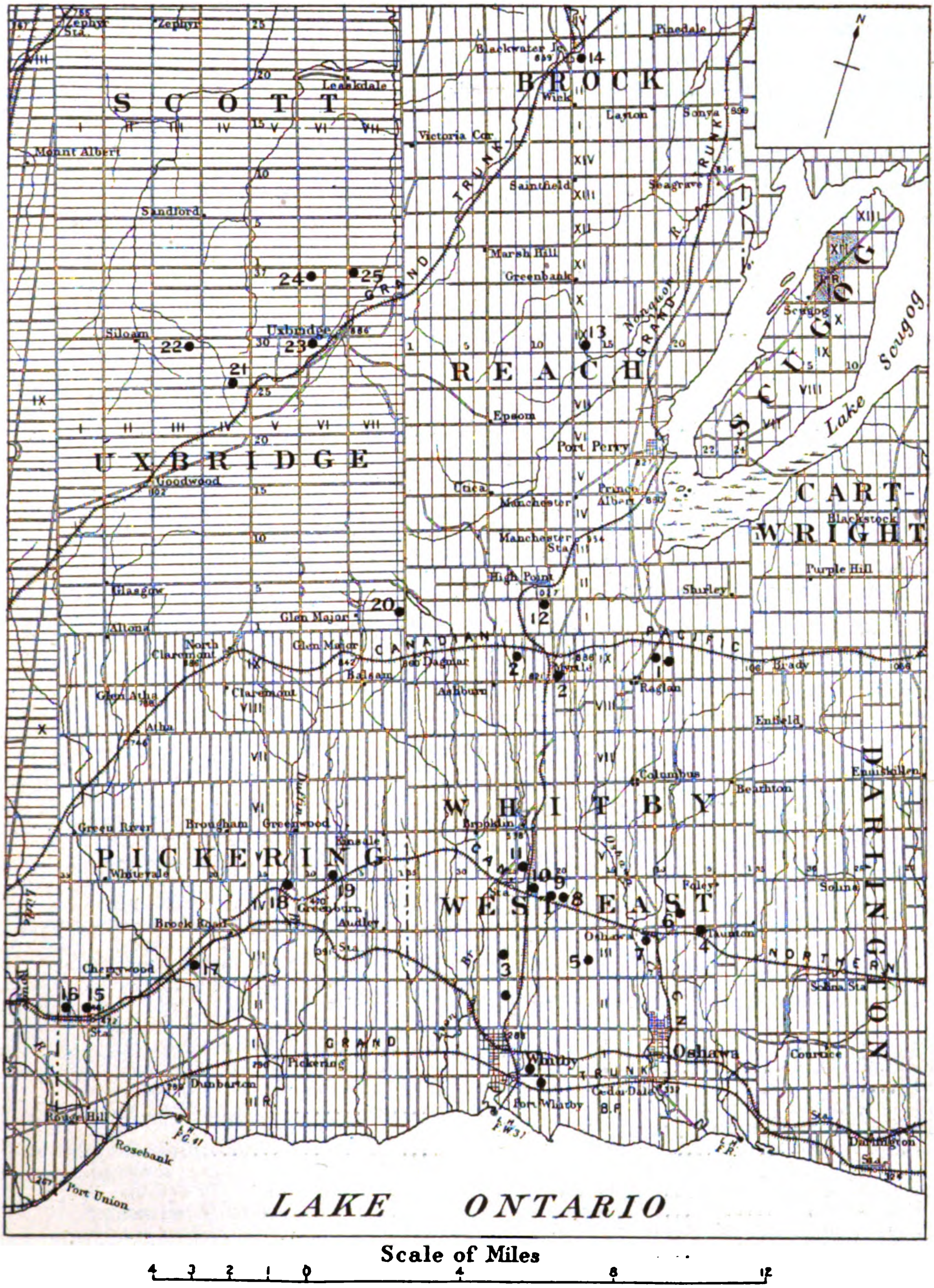


Fig 31—Map of part of Ontario county, showing the location of principal sand and gravel deposits. The numbers refer to the list given in the text.

concessions three and four, Pickering township, near Brock Road, the sand deposits are rather extensive and of great thickness. This material is shipped to Toronto by rail for building purposes. The Iroquois ridge through Ontario county averages more than 300 feet in width. Very large reserves are still available, at least 30,000 by 100 by 2=6,000,000 cubic yards.

North of the Iroquois ridge the region is covered with glacial drift and numerous large boulders. There are many drumlin hills characteristic of the glacial topography. The whole country between the C. N. Ry. and the C. P. Ry. lines is made up of sand; well-borings have shown this formation to extend to a depth of 100 feet before the clay is reached. This sandy formation extends north of the C. P. Ry., as shown in the deep cuttings between Myrtle and High Point. There are large deposits of sand and gravel near Myrtle, Port Perry and Uxbridge. Some moulding sand from a point a little west of the station was used ten years ago by a foundry in Port Perry. One mile south of Uxbridge there is a sandy ridge with numerous pits scattered along it. At the highest point of the ridge some fine white "blow" sand is carried about by the wind, covering the fields and injuring the crops.

To summarize, the eastern part of Ontario county, including the townships of Whitby, Reach, Brock, Thorah, Mara and Rama, has a fair reserve of gravel and sand. There are very few pits in Scugog township. The western row of townships, Pickering, Uxbridge and Scott, have also fairly good reserves of sand suitable for building purposes, and of gravels for ballast and construction work.

The following list gives some details respecting the principal pits in Ontario county (fig. 31):—

No.	Owner	Township, Con. and Lot	Size in ft.	Remarks
1	—— Raglan	Whitby, Con. IX, lot 11–12		Road gravel.
2	—— Myrtle	Whitby, Con. IX, lot 20–25	Depth 40	Sand and gravel.
3	Geo. Hurt, Whitby	Whitby, Con. III, lot 26	75 by 75 by 25	Gravel.
4	S. Burgoyne, Oshawa	Whitby, Con. III, lot 6	200 by 75 by 10	Road gravel.
5	Tp. of Whitby and Town of Oshawa	Whitby, Con. III, lot 17		Road gravel.
6	Cement Brick Co., Oshawa	Whitby, Con. IV, lot 9	300 by 100 by 10	Road and concrete gravel.
7	Canadian Northern Ry	Whitby, Con. III, lot 12	1,300 by 120 by 6	Ballast.
8	Canadian Northern Ry	Whitby, Con. IV, lot 20	1,200 by 200 by 15	Ballast.
9	Tp. of Whitby	Whitby, Con. IV, 20–21	500 by 70 by 10	Road and concrete gravel.
10	G. T. Ry	Whitby, Con. IV, lot 23	1,200 by 250 by 15	Ballast.
11	G. T. Ry	Whitby, Con. V, lot 24	1,000 by 300 by 12	Ballast.
12		Reach, Con. I and II, lot 10	Depth 40	Gravel.
13	Corporation of Port Perry	Reach, Con. X, lot 13		Sand and gravel.
14	Godson Contracting Co., Toronto	Brock, Con. III, lot 13		Gravel, crushed and screened.
15	C. N. Ry. and C. P. Ry.	Pickering, Con. II, lot 32	400 by 75 by 10	Gravel.
16	C. N. Ry	Pickering, Con. II, lot 34	700 by 400 by 10	Ballast.
17	Toronto Builders' Supplies Ltd., Toronto	Pickering, Con. III, lot 22	Very deep	Sand.
18	F. L. Green, Greenwood	Pickering, Con. IV, lot 13	300 by 150 by 10	Road gravel.
19	Godson Contracting Co., Toronto	Pickering, Con. V, lot 8		Gravel.
20		Uxbridge, Con. VIII, lot 2		Sand.
21		Uxbridge, Con. IV, lot 26		Sand.
22	C. Hockley, Uxbridge	Uxbridge, Con. III, lot 30		Gravel.
23	Chapman, Uxbridge	Uxbridge, Con. VI, lot 30		Gravel.
24	H. Alford, Uxbridge	Uxbridge, Con, VI, lot 36		Road gravel.
25	H. Gall, Uxbridge	Uxbridge, Con. VII, lot 37		Gravel.

Granular metric analysis of screened sand, Whitby bay:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.00	7.95	16.35	35.55	50.20	88.10	97.30	98.60	99.00

Per cent. of fineness 45.22
Coefficient of uniformity 52.55
Grade .... No. 5
Real specific gravity 2.824
Apparent specific gravity 1.706
Weight in lbs. per cubic foot .. 106.60
Percentage of voids 39.6

Granular metric analysis of sand, Landshore Sand & Gravel Co., Frenchman's bay:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	0.30	3.10	6.40	16.80	25.70	60.00	93.25	98.40	99.15

Per cent. of fineness 55.2
Coefficient of uniformity 67.55
Grade .... No. 6
Real specific gravity 2.855
Apparent specific gravity 1.693
Weight in lbs. per cubic foot ... 105.785
Percentage of voids 40.7

Granular metric analysis of fine sand, Landshore Sand & Gravel Co., Frenchman's bay:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	41.55	88.25	98.85	100.00	100.00	100.00	100.00	100.00	100.00

Per cent. of fineness 7.93
Coefficient of uniformity 88.25
Grade .... No. 1

Oxford County

Large deposits of gravel occur along the Grand Trunk railway between Dorchester in Middlesex county and Beachville in Oxford county. These deposits were extensively worked by the railway for ballast, principally in the neighbourhood of Ingersoll. One of the excavations was two miles long, 75 feet wide and about 20 feet deep. Large excavations of this kind are located north of the railway between Ingersoll and Beachville. There still remain large reserves available.

Around Woodstock there are some deposits of gravel and sand. South of the town there is a sand ridge containing very large reserves. The gravel is generally made up of limestone, with some igneous and metamorphic rocks. The pebbles are as a rule under 2 inches in diameter. The material is sold at an average of 70 cents a cubic yard for delivery in town.

Different grades of sand are found here; they are mostly used for building purposes. Following is a list of the principal pits in the vicinity of Woodstock:

Owner	Location	Size in ft.	Output	Remarks
——Butterfield, Woodstock	Southern part of Woodstock.	40 by 30 by 12	100 yd.	10 ft. sand and little gravel.
C. E. Rapson, Woodstock..	Woodstock..............	20 deep	....	Sand and cement gravel.
C. E. Rapson, Woodstock ..	Blandford tp., Con. II, lot 17.	60 by 60 by 15	....	Sand and gravel. Reserve 10 ac.
——Silcox, Woodstock.....	Blandford tp. Con. II, lot 14.	....	....	Large reserves of sand and gravel.
——Blair, Woodstock	Blandford tp., Con. II, lot 13.	....	....	Large reserves of sand and gravel.
Silvester Keys, Woodstock.	East Oxford tp., Con. III.	....	....	Big ridge, about 35 acs. of gravel.

Granular metric analysis of sand from Butterfield's pit, Woodstock:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	1.60	3.75	5.20	12.65	25.45	73.15	88.35	93.20	97.25

Per cent. of fineness	55.55	Apparent specific gravity	1.642
Coefficient of uniformity	62.90	Weight in lbs. per cubic foot...	102.60
Grade	No. 6	Percentage of voids	42.2
Real specific gravity	2.838		

Peel County

There is not much material available in the southern part of this county near the shore of Lake Ontario. In the township of Chinguacousy there are some deposits round Brampton and along the Credit river, and in the northern township of Caledon, some large gravel deposits are found in the Credit river valley near Cataract.

At Brampton, the pits contain mostly sand and gravel, the thickness of the respective layers varying from one pit to another. At the top there are often one or two feet of loam, then 2 to 15 feet sand, and below this again gravel of various grades. There is a little pea gravel, but as a rule the pebbles are rather large and made up of sandstone, limestone, granite and some metamorphic rocks. The pits are deep and the walls stand up well, the gravel showing some auto-cementing power. The principal deposits here form part of a ridge running north and south from lot 5 to lot 12, in concessions one and two, in the eastern part of Chinguacousy.

In the same township deposits along the Credit river are worked near Huttonville, principally for small gravel. This material is sold, as in Brampton, for 25 to 40 cents a yard at the pit.

Large pits were opened near Cataract in the Credit river valley. The gravel is coarse and made up mostly of sandstone, shaly sandstone, igneous and metamorphic rocks. The pits are located on the east bank of the river and mostly

in the concave bends. This gravel was probably brought down by the river during the formation of the valley. The walls of the pits are about 70 feet high. The deposits are extensively worked by steam shovels, the material being used as ballast and road gravel.

The following list gives some details about the pits met with in Peel County:

Owner	Township, Con. and Lot	Size in ft.	Output	Remarks
John Parr, Brampton	Chinguacousy, Con. 2E, lot 5.	30 by 60 by 30	....	Several other small pits, gravel and sand.
W. B. Markle, Brampton..	Chinguacousy, Con. 2E, lot 6.	150 by 30 by 30	....	Sand and gravel.
Town of Brampton.......	Chinguacousy, Con. 2E, lot 12	300 by 300 by 30	....	Road gravel.
Ackroyd, Stanley Mills ..	Chinguacousy, Con. 5E, lot 10	100 by 60 by 15	....	Pea gravel and sharp sand
John Reid, Huttonville....	Chinguacousy, Con. 4W, lot 5	....	....	Small reserves of gravel
J. W. Chesney, Huttonville	Chinguacousy, Con. 5W, lot 5	150 by 100 by 10	Small...	Bucket elevator and screener.
A. Laidlaw, Norval	Chinguacousy, Con. VI, lot 7	....	....	Gravel.
....	Chinguacousy, Con. V, lot 7	....	....	Sand.
A. Laidlaw, Norval	Chinguacousy, Con. VI, lot 10	150 by 100 by 5	150 yd..	Cement gravel, mostly limestone pebbles and sand.
Hydro-Electric Com., Toronto	Caledon, Con. III, lot 14 (Cataract)	300 ft. along the Credit R. 70 ft. high.	....	Coarse gravel.
Canadian Pacific Railway.	Caledon, Con. III, lot 14	500 ft. along the Credit R. 65 ft. high.	....	Gravel.

Granular metric analysis of sand from John Parr's pit, Brampton:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	1.05	5.85	8.95	36.35	67.05	86.75	94.95	96.85	98.35

Per cent. of fineness 44.87
Coefficient of uniformity 58.10
Grade .... No. 5
Real specific gravity 2.763
Apparent specific gravity 1.623
Weight in lbs. per cubic foot .. 101.41
Percentage of voids 41.3

Granular metric analysis of gravel from Markle's pit, Brampton:—

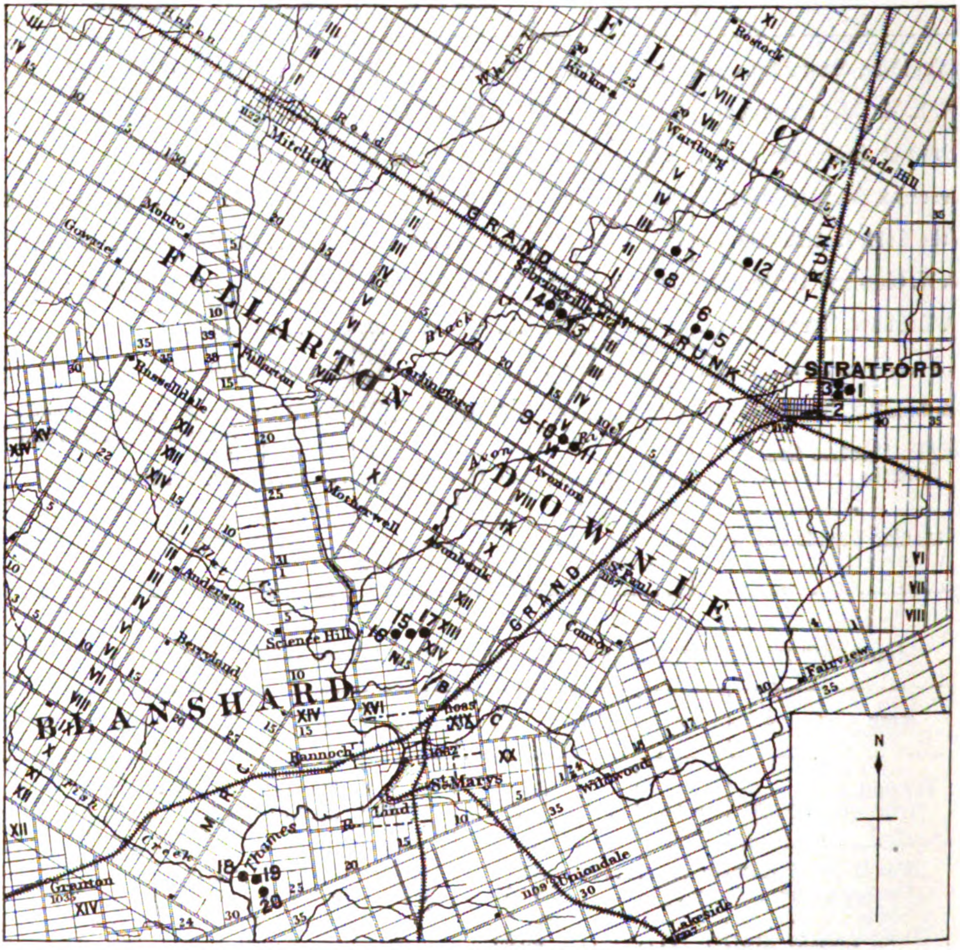
Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained.	38.25	58.65	67.35	80.45	87.65	96.30	98.45	98.90	99.55

Per cent. of fineness 19.4
Coefficient of uniformity 58.65
Grade .... No. 1

Perth County

A great number of deposits are to be found in the southern part of this county near Stratford and St. Marys, in the form of gravel ridges (fig. 32).

To the east of Stratford in the township of North Easthope, two ridges run in a direction from east to west through lots 43 and 44 of concession one. The material is a coarse road gravel, mostly of limestone. It is sold at about 40 cents a yard.



Scale of Miles
4 3 2 1 0 4 8

Fig. 32—Map indicating the location of sand and gravel pits in the vicinity of Stratford and St. Marys. Numbers refer to the list in the text.

West of Stratford and about 400 yards north of the Huron road there is a similar ridge running approximately parallel to the road, and at least three miles long. It passes through lots 8 to 12 in concession one of Ellice township and then bends southwards into the township of Downie. A small pit is to be found on the southern side of the Huron road where the ridge crosses the latter. Other ridges are to be seen to the north in Ellice, and some parts of the county are completely overlaid by gravel.

Deposits of gravel of several grades used for road and cement purposes, occur south of Sebringville, on the shore of Black creek. They are probably due to floodings of this creek. The material sometimes contains a little sand. The cement gravel is sold at 50 cents a yard, the road gravel at 12½ cents, and the sand at 50 cents. The pebbles are mostly limestone, but there is a fair proportion of sandstone, as well as some gneiss and granite fragments.

Another gravel ridge extends through concession five, of Downie township, a little northeast of Avonton, on both sides of the Avon river.

In the southern part of Downie, there is a very large ridge containing sand and gravel of fine quality, extending through lots 14, 15, 16 in concession fourteen, and passing into Blanshard township. The sand is sold at 40 cents a yard, the gravel at 35 cents. Much of this material is used in St. Marys for building purposes.

South of St. Marys in concession eight, several large pits are located in lots 28 and 29 on a ridge running north and south. Hills on this ridge indicate where the material is very abundant. They are made up of coarse gravel on top, and cement gravel at the bottom. Stratification is oblique. The pebbles are mostly of limestone, with some sandstone, granite and gneiss. The material is sold at low prices, about 60 cents to $1.00 a cord (12 to 20 cents a yard) for cement gravel and 50 cents a cord (10 cents a yard) for road gravel.

GRAVEL AND SAND PITS IN PERTH COUNTY

No.	Owner	Township, Con. and Lot	Size in feet	Output	Remarks
1	John Sebben. Stratford	N. Easthope, Con. I, lot 43	10 deep	....	Road gravel and 3 ft. sand.
2	Henry Kirby, Stratford	N. Easthope, Con. I, lot 44	....	500 yd.	Road gravel.
3	Henry Kirby, Stratford	N. Easthope, Con. I, lot 44	100 by 100 by 20	....	Road gravel. Reserve, 4 ac.
4	Wm. McKay, Stratford	Downie	125 by 125 by 20	900 yd.	Road and cement gravel. Coarse sand.
5	Mrs. M. Roadhouse, Stratford	Ellice, Con. I, lot 8.	100 by 125 by 6	....	Cement gravel.
6	J. R. Schenck, Stratford	Ellice, Con. I, lot 9.	75 by 75 by 6	....	Gravel.
7	Chas. Finnegan, Stratford	Ellice, Con. III, lot 14	450 by 300 by 25	600 yd.	Gravel. Reserve 10 acres.
8	Wilmot Frazer, Stratford.	Ellice, Con. II, lot 14	Small pit	....	Gravel.
9	James Mills Stratford	Downie, Con. V, lot 12	150 by 75 by 15	400 yd.	Gravel. Reserve, 750 by 75 by 15 ft.
10	John Munroe, Stratford	Downie, Con. V, lot 12	500 by 150 by 10	....	Gravel.
11	Thos. Aitcheson, Stratford	Downie. Con. V, lot 11	150 by 100 by 20	....	Gravel.
12	Wm. Malloy. Stratford	Ellice, Con. IV, lot 8	300 by 300 by 25	2,500 yd.	Cement, and road gravel and sand. Reserve, 50 ac.
13	Geo. S. Litt, Sebringville	Downie, Con. II, lot 18	309 ft. along Black Cr. 15 ft. high	350 yd.	Cement and road gravel, sand.
14	Dillman K. Erb, Sebringville	Downie, Con. II, lot 19	400 by 100 by 20	300 yd.	Cement and road gravel.
15	Edward Betridge	Downie, Con. XIV, lot 15	75 by 40 by 8	150 yd.	Road and cement, gravel and sand.
16	Gourley	Downie, Con. XIV, lot 16	....	....	Gravel.
17	Wm. White, St. Marys	Downie, Con. XIV, lot 14	100 by 150 by 20	1,000 yd.	Gravel and sand. Reserve, 20 ac.
18	Jas. Harris, St. Marys	Con. VIII, lot 29	450 by 450 by 25	4,000 yd.	Road and cement gravel.
19	Robert Fewster, St. Marys	Con. VIII, lot 28	300 by 150 by 20	750 yd.	Road and cement gravel.
20	Malcolm Conn, St. Marys	Con. VIII, lot 28	150 by 150 by 10	....	Gravel and sand.

Granular metric analysis of sand from Sebben's pit, Stratford:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.10	0.30	0.85	24.35	79.35	92.45	98.85

Per cent. of fineness	67.08
Coefficient of uniformity	78.50
Grade	No. 6
Real specific gravity	2.938
Apparent specific gravity	1.524
Weight in lbs. per cubic foot	95.225
Percentage of voids	48.1

Granular metric analysis of cement gravel from Edward Betridge's pit, Downie tp.:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	47.60	61.65	68.60	80.55	87.50	95.85	97.50	97.90	98.45

Per cent. of fineness	16.04
Coefficient of uniformity	61.65
Grade	No. 1

Granular metric analysis of gravel from M. Harris' pit, St. Marys:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	54.15	64.75	69.80	80.55	87.85	97.10	99.00	99.45	99.80

Per cent. of fineness	16.4
Coefficient of uniformity	64.75
Grade	No. 1

Peterborough County

The pits examined in this county are all situated in the city of Peterborough and vicinity. There are some other deposits in the southern part of the county.

The deposits near the city of Peterborough are composed of sand and gravel in alternating layers. The corporation pit, which is located at the north end of the city on the west shore of the Otonabee river, shows on top three yards of fine gravel, underneath which are three feet of sharp sand, then three feet of sandy gravel, then two yards of coarse gravel, and at the bottom large boulders. The excavation, which is about 300 by 60 by 40 feet in size, is part of a ridge, which contains much suitable material; but houses have been built on it so as to render a large proportion of the deposit unavailable.

Just north of the corporation pit there is another pit 250 by 60 by 60 feet in size, which is owned by Mr. Stothart, and shows a similar section. In both pits the gravel contains 75 per cent. limestone, the remainder being granite and metamorphic rocks.

There are several other pits, among which is the Brown pit, 1,000 by 60 by 30 ft. in size, located on the same ridge running parallel to the Otonabee river. This ridge is parallel with the Lakefield road for about one mile, and then turns west at a point about three miles north of the centre of Peterborough.

At the southern end of the city, near the cemetery, J. T. O'Connell owns a sand pit about 200 by 120 by 10 ft. in size, containing layers of coarse sand and pea gravel. The present output of this pit is very small.

Granular metric analysis of sand from T. O'Connell's pit, Peterborough:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	2.55	6.05	11.90	44.30	72.85	92.55	95.55	97.15	98.90

Per cent. of fineness	42.02	Apparent specific gravity	1.611
Coefficient of uniformity	60.95	Percentage of voids	42.5
Grade	No. 4	Weight in lbs. per cubic foot ...	100.66
Real specific gravity	2.805		

Prescott County

Sand is dug from the shores of the Ottawa river at the northern limit of this county. It is similar in character to the material obtained in the vicinity of the city of Ottawa.

In the neighbourhood of Vankleek Hill there are some gravel and sand deposits. The gravel is composed principally of limestone pebbles. In certain layers the gravel is fine and intermixed with sharp sand in such a proportion that good concrete is obtained in mixing cement with this gravel in the ratio 1 to 7. The reserves of sand and gravel near Vankleek Hill are very large. Details of the principal pits of this region are given below:—

Owner	Township, Con. and Lot	Size in ft.	Output	Remarks
Corporation of Vankleek Hill....	Hawkesbury, W., Con. VI, lot 11...	75 by 75 by 5	....	Gravel.
D. A. McPhee, Vankleek Hill.....	Hawkesbury, W., Con. VI, lot 10...	400 by 75 by 6	....	Fine pea gravel. Reserve, 15 ac.
A. J. Cross, Vankleek Hill	Hawkesbury, W., Con. IV, lot 18...	100 by 100 by15	100 yd.	Sand and cement gravel. Reserve, 1.5 ac.
——Duff, Vankleek Hill,....	Hawkesbury, W., Con. IV, lot 16...	....	....	Sand.

Granular metric analysis of sharp sand from A. J. Cross' pit, Vankleek Hill:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0	0.20	1.75	27.90	65.20	91.30	97.05	98.35	99.15

Per cent. of fineness	46.57	Apparent specific gravity	1.514
Coefficient of uniformity	63.45	Weight in lbs. per cubic foot ...	94.60
Grade	No. 4	Percentage of voids	43.6
Real specific gravity	2.685		

Prince Edward County

The most extensive deposit of sand in this county, and one of the largest in southern Ontario, is the sandbar south of Wellington. The bar has a direction N.40°W., and is located between Lake Ontario on the west and Yeo lake on the east, making a small strip of ground which is wider to the south. It starts south of Wellington and extends for five miles to Owen Point (fig. 33).

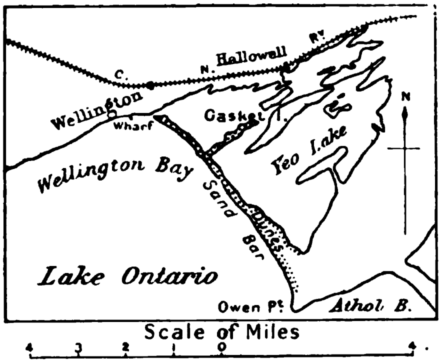


Fig. 33—Sketch indicating the location of the sandbar between Wellington and Owen Point.

At its northern end, that part of the bar above the lake level is only about 25 yards wide. An east-west section in this part is shown in fig 34. On the western side gravel and sand are continuously deposited. The sand is rather sharp, while the gravel is composed of limestone pebbles of varying sizes and a small proportion of granitic material.

The bar remains only 25 yards wide for two miles, then it widens and sand dunes appear in the centre of the bar (fig. 35).

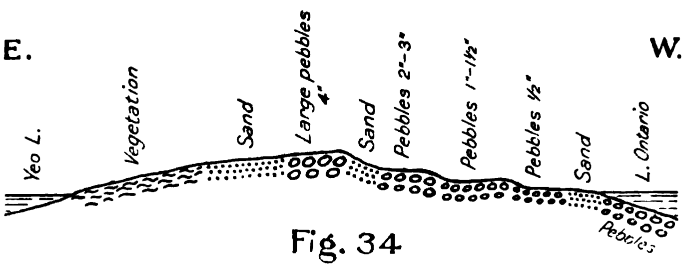


Fig. 34—Section of the northern end of the Wellington sandbar.

The dunes are composed of very white fine sand, while the sand near the shore is coarser and sharper, and contains more ferro-magnesian minerals. The dunes are higher farther south where the bar is wider. About four miles south of Wellington, the dunes have advanced eastwards so as to cover a large area of agricultural ground. Sixty years ago they were close to the shore of Lake Ontario; to-day in the vicinity of Sandbanks they have advanced 500 yards from the shore, and form a ridge extending north and south with an approximate width of 500 yards (fig. 36).

The highest point of this ridge is about 150 feet above the water level.

The amount of sand available is very large. Taking a length of five miles and an average width of 260 yards, the reserve would cover an area of 2,288,000 square yards. With an average height of 20 yards, the total volume may be estimated at 45,760,000 cubic yards.

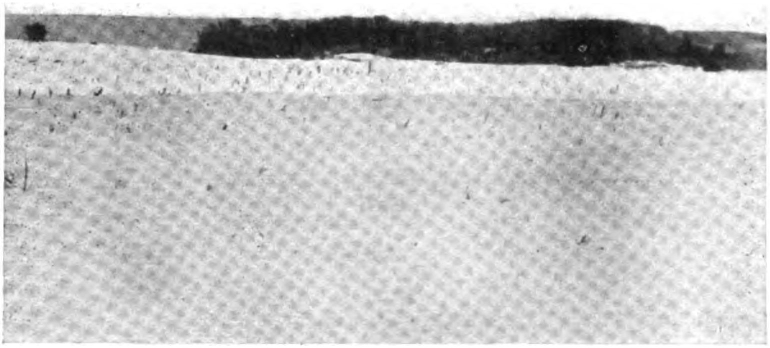


Fig. 35—Sand beach, two miles south of Wellington.

The dune sand is in general too fine for building purposes, but it has been suggested that some parts could probably be used for making ordinary bottle glass. A microscopical examination of samples taken at different parts of the bar shows that it is composed principally of glassy quartz particles, some of which are covered by rust. Among the other minerals observed were calcite,

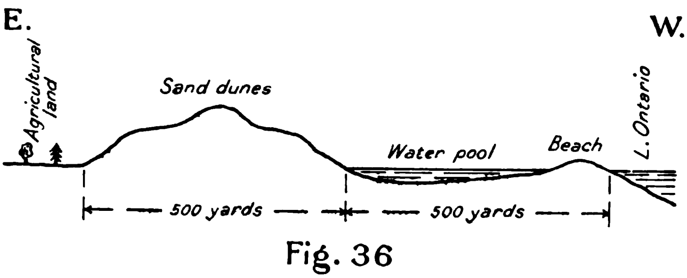


Fig. 36—Section of the southern end of the Wellington sandbar.

orthoclase, plagioclase, magnetite, rutile, garnet, hornblende and tourmaline. In the shore sand, the proportion of quartz is larger north of the bar than to the south, where garnet and magnetite become more abundant and give to the sand a darker colour. The dune sand is finer grained, and the proportion of heavy ferro-magnesian minerals it contains is lower than in the beach sand, although the coloured minerals account for 5 to 10 per cent. of the whole mass.

In its natural state, this sand seems unsuitable for glass on account of the ferro-magnesian minerals present, but a large amount of the iron-bearing minerals may be extracted by a magnetic separator. Magnetite, garnet, hornblende and

tourmaline are the principal minerals found among the extracted particles. The average proportion of the separated material, in four experiments, amounted to 6.72 per cent.

Chemical analysis of the dune sand of the Wellington bar (1) in its natural state and (2) after magnetic separation gave the following results:

	(1) Per cent.	(2) Per cent.
Silica	59.60	61.69
Alumina	8.52	10.25
Ferric oxide	2.46	0.80
Ferrous oxide	1.64	0.95
Lime	12.61	12.38
Magnesia	1.86	1.33
Potash	2.02	1.62
Soda	2.58	2.72
Water	0.29	0.31
Carbon dioxide	8.36	8.20
Total	99.94	100.25

Norms calculated from the preceding analyses:—

		(1) Per cent.		(2) Per cent.
Calcite		19.00		18.60
Orthoclase	11.68	39.25	9.45	42.24 feldspars
Albite	22.01		23.06	
Anorthite	5.56		9.73	
Magnetite		3.71		1.16
Corundum		....		0.51
Wollastonite		1.74		....
Enstatite		4.60		3.30
Grünerite		0.92		1.19
Quartz		30.42		33.00
Water		0.29		0.31
Total		99.93		100.31

These figures show that this sand is composed of very mixed materials: feldspars, quartz and calcite are the principal constituents, but the proportion of pure quartz is rather small. The magnetic separation process applied to this sand only separates some magnetite and iron-bearing silicates, and the general composition of the sand is not much improved. For glass-making, the requirements are generally 98 to 99 per cent. of silica, and only traces of iron oxides. These requirements are not met by the sand of Prince Edward county dunes.

Granular metric analysis of sand from central portion of the Wellington dunes:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	0.0	0.0	0.25	63.75	94.45	100.00

Per cent. of fineness	71.28	Apparent specific gravity	1.575
Coefficient of uniformity	94.20	Weight in lbs. per cubic foot	98.41
Grade	No. 7	Percentage of voids	46.3
Real specific gravity	2.937		

N.B.—The material remaining on the 200-mesh and passing the 100-mesh is darker than that remaining on the 100-mesh; this is again darker than the material remaining on the 80-mesh.

Granular metric analysis of sand from eastern slope of the dunes:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	0.0	0.05	3.10	85.60	98.70	99.80

Per cent. of fineness	68.08	Apparent specific gravity	1.558
Coefficient of uniformity	95.6	Weight in lbs. per cubic foot ..	97.35
Grade	No. 7	Percentage of voids	44.8
Real specific gravity	2.823		

N.B.—The small particles contain most of the dark minerals.

Renfrew County

Between Eganville and Golden Lake this country is underlain by granitic rocks covered with forest, the rock at some places being concealed by lenses of brown sand. Similar occurrences exist between Golden Lake and Pembroke. The sand is very often intermixed with pebbles, and grades into gravel. This material has been extensively used by the G. T. Ry. as ballast. West and south of Pembroke the greater part of the area for about two miles is sandy. There is generally some loam at the top, and under it a coarse sharp, brown sand mixed with pebbles, underlain by white sharp sand. It should be noticed that the percentage of limestone pebbles is smaller than usual in the gravel deposits, there being frequently 50 per cent. of granite and metamorphic rocks.

There is an extensive sandy area near Haley on the C. P. Ry. line, and near Olmsted lake. From 6 to 10 miles northwest from Arnprior, there is a sand and gravel beach along the Ottawa river near Castleford and Sandpoint. The sandy formation here covers the limestone outcrops near the river to a height of 50 feet above the present water level.

Arnprior also gets some sand and gravel from pits located in the north-western end of Carleton county.

SAND AND GRAVEL PITS EXAMINED IN RENFREW COUNTY.

Owner	Location	Size in feet	Remarks
Wm. Markus, Ltd. Pembroke	1 mile S.-W. of Pembroke.	500 by 250 by 40	Brown sand and gravel near top; white sand near bottom.
Johnson Griffith, Pembroke	1 mile S.-E. of Pembroke.	100 by 100 by 8	Concrete gravel. Reserves, 4 acres.
James Stewart, Arnprior......	3 miles S. of Arnprior...	....	Road gravel.

Granular metric analysis of brown sand from pit of W. Markus, Ltd., Pembroke:—

Mesh	4	8	10	20	28	48.	80	100	200
Per cent. retained ...	32.85	39.20	42.50	54.10	69.30	93.85	97.95	98.75	99.60

Per cent. of fineness	30.2	Apparent specific gravity	1.687
Coefficient of uniformity	39.75	Weight in lbs. per cubic foot ...	105.40
Grade	No. 5	Percentage of voids	38.5
Real specific gravity	2.746		

Russell County

The principal deposits in this county are located at Bear Brook, Bowesville, Brisson, Casselman, Cumberland, and Leonard. The deposits around Casselman, in the township of Cambridge, were visited. These consist of deposits of building sand, moulding sand and gravel, but no extensive work has been done in recent years. The whole district around Casselman is rather sandy, but there is no large market for ordinary sand and gravel in the neighbourhood.

On the other hand, the moulding sand of this region has not been worked, although there are large reserves northwest of Casselman. These moulding sand deposits are well shown on the north side of the G. T. Ry. line between a point about two miles west from Casselman, and the station of South Indian. It occurs as fine grained material in a layer one or two feet thick under the loam.

PITS EXAMINED IN RUSSELL COUNTY.

Owner	Township, Con. and Lot	Size in feet	Remarks
Ad. Rainville, Casselman........	Cambridge, Con. VI and VII, lot 15	100 by 100 by 30	Principally sand and a little gravel. Reserve, 1.5 acre.
A. F. Durivage, Casselman........	Cambridge, Con.VIII, lot 7..............	200 by 100 by 6	Sand.
Dieudonne Forgues, Casselman........	Cambridge..........	90 by 60 by 8	Cement gravel.

Granular metric analysis of sand from Ad. Rainville's pit, Casselman:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0	tr.	0.15	5.05	26.30	72.00	92.50	96.45	99.05

Per cent. of fineness	56.5	Apparent specific gravity	1.589
Coefficient of uniformity	66.95	Weight in lbs. per cubic foot ...	99.29
Grade	No. 5	Percentage of voids	43.2
Real specific gravity	2.795		

Simcoe County

The greater part of this county was covered by the waters of the ancient Lake Algonquin. About three-fifths of the whole area is now covered by surface deposits due to the action of this lake. Several shore lines may be followed through the county. The principal one, known as Algonquin Lake shoreline (fig. 37) enters the southeastern corner of the county through the township of Gwillimbury west and runs in a north-northeasterly direction about parallel to the boundary of the county and the western shore of Lake Simcoe.

At a point about two and a half miles from Big Bay point, the shoreline turns west, passing near Allandale, Colwell and Angus, where it turns again south as far as Beeton, in Tecumseth township. From this point it runs in a more or less straight line about N.40°W. through the townships of Tecumseth, Adjala, Tosorontio, and Nottawasaga, and crosses the county boundary to enter Collingwood township in Grey county. Between Lake Simcoe and the Georgian Bay there are some large islands of Lake Algonquin marked by their old shorelines. In the whole of Simcoe county the Algonquin shore line is between 750 and 775 ft. above sea level.

The preceding facts are of interest for the location of sand and gravel surface deposits. Practically the whole district south of the ancient shoreline consists of good farming lands. Such is the case for the greater part of the townships of Gwillimbury West, Tecumseth, Adjala, Innisfil, and Essa. Good farming land is also found in the northern part of Simcoe county, in the townships of Oro, Vespra and Tiny, which existed during Algonquin times as large islands.

The remainder of the county was covered by Lake Algonquin, and shows to-day extensive deposits of sand, gravel, and clay. This is the case in the greater part of Medonte, Orillia, Tay, Flos, Sunnidale, and Tosorontio townships. It should also be noticed that other shorelines higher than the Algonquin line are marked locally by sand and gravel deposits.

The most abundant deposit of Lake Algonquin is a brownish red or reddish brown sand, too fine in size to be of economical value, as shown by the granular metric analysis. It can be well seen in the cuttings of the Nottawasaga river in Tecumseth and Essa townships. The upper part of the section is this reddish sand; under it comes some finer white sand approaching quick sand, and at the bottom of the valley there is some silty, impermeable clay. Borings for water at Camp Borden, in Essa township, showed a similar section: under the clay the borings struck a formation of sand and gravel containing water coming from Lake Simcoe, altitude 718 feet, and well filtered during its underground course. In some borings made at Camp Borden 45 feet of sand were found below the 630 feet altitude and over the clay.

To get a general view of these surface deposits, a trip was begun from Coldwater, in Medonte township, taking the C.P.Ry. in a southwesterly direction. Near Coldwater there is some sand. Gravel excavations and cuttings occur near Eady station; the brown ferruginous sand is very abundant near Carley station, where it extends over miles of the country. It can be followed for ten miles along the C.P.Ry. tracks, being sometimes mixed with pebbles and used for ballast. This sand formation is also very characteristic near Craighurst, in the southwest corner of Medonte township. It runs also over Vespra township; the sand shows a

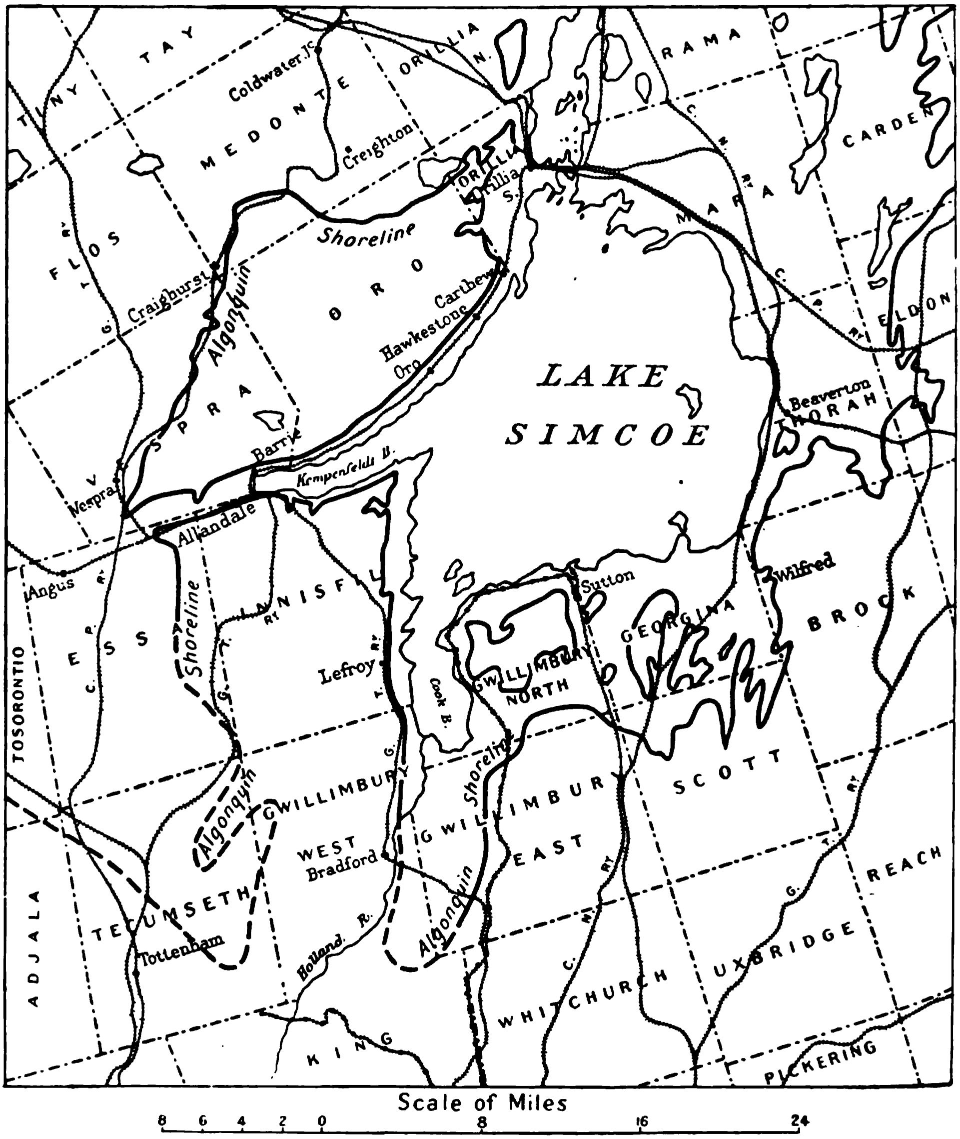


Fig. 27—Map of Lake Simcoe showing portions of the counties of Simcoe, York and Ontario. The approximate location of the shore line of ancient Lake Algonquin is indicated by a heavy line.

thickness of more than 100 feet in a big ravine, north of Midhurst station. South of Vespra township there is the ancient channel between a large island and Lake Algonquin shore; here the pebbles become more abundant, and large deposits of gravel occur southeast of Utopia station, near the boundary of Essa township. The region around and west of Angus is very sandy; the greatest part of this surface sand is a fine dune sand.

Sand dunes form a ridge near the southern boundary line between Sunnidale and Tosorontio townships. An extensive area covering parts of Essa, Tosorontio, Adjala and Tecumseth townships is part of a large bay of ancient Lake Algonquin. This bay has been completely filled by sand, and at present forms a country made up of large pine plains and extensive barren sandy grounds. It is in this region that Camp Borden is located.

Near Orillia, there are large deposits of sand and gravel between the present shore of Lake Couchiching and the shore line of a large ancient island of Lake Algonquin. This line runs about parallel to the western shores of Lake Simcoe and Lake Couchiching from Barrie to the northern end of Lake Couchiching. Lake Simcoe is, in fact, a remaining part of the channel between this large island and the shore of Lake Algonquin. Similar formations are found near Barrie and Allandale.

The region near Collingwood, in the northwest corner of Simcoe county, is a good example of recent detrital formation. Collingwood is on Nottawasaga Bay, near the southern point of Georgian Bay. To the east of the town, there is a gravel area still in formation, as can be seen along the creeks. The bottom of these creeks is made of shaly Ordovician limestone, covered by very angular pebbles of the same material. In summer time many of the creeks are dry, but during the winter the lake and the creeks carry this gravel over the adjoining area about six miles in an east-west direction and one mile in a north-south direction. The depth is variable and generally not more than four feet. The gravel is not of first-class quality, and only small pits have been opened in it. Going east the gravel turns gradually into sand. On the beach, six miles from Collingwood, the sand still contains some gravel, but farther east it becomes a characteristic beach sand extending ten to twelve miles along the shore to the mouth of the Nottawasaga river. The sand contains some magnetite and garnet grains, and is used for building purposes. The beach, not covered by vegetation, is at present 30 to 50 feet wide. It was from 150 to 200 feet some years ago, when the level of the lake was much lower.

Granular metric analysis of sand near the surface, Camp Borden:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	0.0	tr.	1.70	23.60	57.80	96.00

Per cent. of fineness	80.1	Apparent specific gravity	1.527
Coefficient of uniformity	72.40	Weight in lbs. per cubic foot ..	95.41
Grade	No. 8	Percentage of voids	48.3
Real specific gravity	2.958		

Granular metric analysis of silty sand, Camp Borden:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	0.0	tr.	1.25	2.00	5.70	41.50

Per cent. of fineness 94.39

Coefficient of uniformity 94.30

Grade .... No. 9

Granular metric analysis of sand from Nottawasaga bay, seven miles east of Collingwood:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	tr.	tr.	13.80	82.95	98.10	99.95

Per cent. of fineness 67.24

Coefficient of uniformity 84.30

Grade .... No. 7

Real specific gravity 2.864

Apparent specific gravity 1.633

Weight in lbs. per cubic foot ... 102.04

Percentage of voids 42.9

Stormont County

Deposits of sand and gravel are abundant in this county (fig. 38) as shown by the numerous excavations. These pits are mostly not very large, although they have a great quantity of material in reserve; the demand, however, is small. The deposits are generally in the form of irregular lenses of sand and gravel intermixed; the sand is rather sharp and is sometimes black in colour from the presence of the limestone grains. The gravel is generally sandy, 60 to 90 per cent. of the pebbles being composed of limestone, the remainder being granitic material. The size is variable, but the average is a fine gravel, large pebbles and boulders occuring only on top of the deposits. These materials are sold at various prices, but on the average the pit owners ask 50 cents a yard for building sand or cement gravel, and 25 cents a yard for road gravel. The writer visited a number of pits located near the southern boundary of the county, and others on both sides of the New York and Ottawa railway. A list of the principal excavations follows:—

No.	Owner	Township, Con. and Lot	Size in ft.	Output	Remarks
1	Ephraim Aube, Berwick	Finch, Con. VII, lot 18	120 by 50 by 10	200yd.	Nearly all building sand.
2	Henri Canneer, Berwick	Finch, Con. V, lot 20.	40 by 25 by 8	100yd.	Road gravel. Reserve, 0.5 ac.
3	Alfred Casselman, Berwick	Finch, Con. VI, lot 17.	125 by 125 by 8	100yd.	Road and cement gravel and sand. Reserve, 1.5 ac.
4	Guy Empey, Finch	Finch, Con. IV, lots 15, 16	30 by 60 by 5; 100 by 40 by 6	......	Two gravel pits. Reserve, 5 ac.
5	Michael Godard, Crysler	Finch, Con. IX, lot 20	500 by 125 by 12	300yd.	Gravel and sand. Reserve. 10 ac.
6	Wesley Hume, Northfield	Finch, Con. V, lot 19.	100 by 25 by 12	......	Road gravel. Reserve, 1 ac.
7	Ronald McMillan, Finch	Finch, Con. IV, lot 19,	150 by 100 by 7	300yd.	Road and cement gravel. Reserve, 2 ac.
8	Wm. Bowles, Newington	Osnabruck, Con. VIII, lot 28.	175 by 100 by 8	......	Sharp sand and pea gravel. Reserve, 2 ac.
9	J. Joint, Newington	Osnabruck, Con. VIII.	150 by 100 by 4	......	Road gravel. Reserve, 2 ac.
10	Jas. Winter	Osnabruck, Con. VIII, lot 22	150 by 100 by 9	......	Sand and gravel. Reserve, 7 ac.
11	Albert Aimable, Moulinette	Cornwall	....	......	Gravel.
12	Thos. Cleary, Mille Roches	Cornwall, Con. I, lot 28	120 by 60 by 10	300yd.	Sand and gravel. Reserve, 1.5 ac.
13	Alexander Day. Mille Roches	Cornwall, Con. III	60 by 60 by 8	......	Road and cement gravel; sand.
14	Hugh McGillis, Harrison Corners	Cornwall	120 by 120 by 7	......	Coarse gravel. Large reserves.
15	Herbert Mattice, Wales	Cornwall, Con. II, lot 34	125 by 125 by 20	......	Gravel and sand of various grades. Reserve, 2 ac.
16	Wm. Murphy. Wales	Cornwall, Con. II. R. 5, lot 36.	500 by 100 by 9	......	Gravel. Reserve, 8 ac.
17	Geo. Murray, Cornwall	Cornwall, Con. VI, lot 31	150 by 100 by 12	......	Coarse gravel.
18	Howard Winters, Mille Roches	Cornwall, Con. III, lot 24	500 by 250 by 15	250yd.	Fine gravel. Reserve, 7 ac.
19	Cory Woods, Moulinette	Cornwall	....	......	Gravel.

Granular metric analysis of sand from Michael Godard's pit, Crysler:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.10	0.30	0.50	8.90	42.05	65.20	90.40

Per cent. of fineness	76.95	Apparent specific gravity	1.568
Coefficient of uniformity	56.30	Weight in lbs. per cubic foot	97.975
Grade	No. 7	Percentage of voids	43.04
Real specific gravity	2.753		

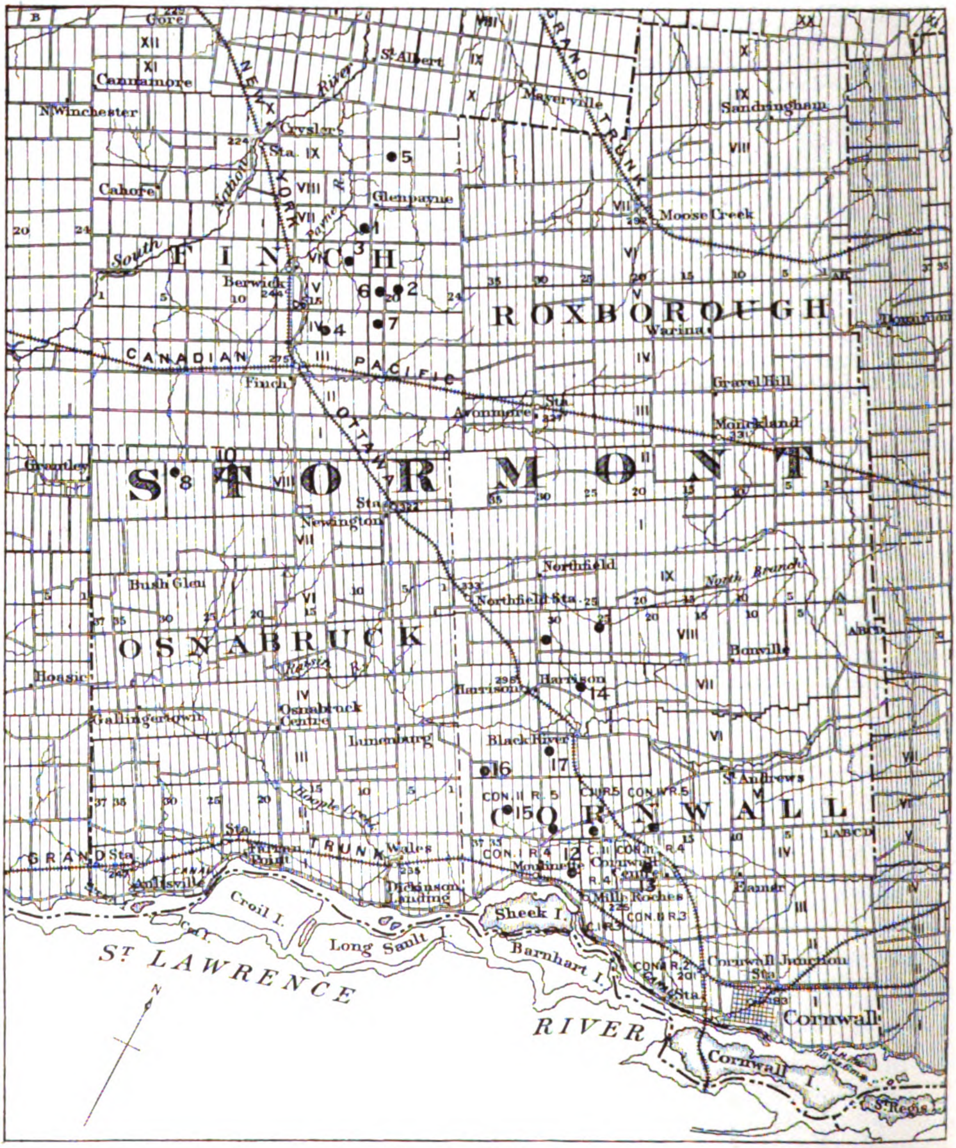
Granular metric analysis of fine sand from H. Mattice's pit, Moulinette:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	tr.	tr.	0.10	0.50	7.45	61.25

Per cent. of fineness	92.3	Apparent specific gravity	1.434
Coefficient of uniformity	92.55	Weight in lbs. per cubic foot	89.60
Grade	No. 9	Percentage of voids	54.7
Real specific gravity	3.168		

Victoria County

The shoreline of the glacial lake Algonquin passes through the townships of Dalton, Carden, Bexley, Fenelon, Somerville, and Eldon. The usual deposits of sand and gravel occur along this line, for instance, near Argyle, Kirkfield, Baddow, and Fenelon Falls.



Scale of Miles

4 3 2 1 0 4 8 12

Fig. 38—Map of Stormont county, showing the principal sand and gravel pits. Numbers refer to the list given in the text.

In the township of Fenelon there are extensive deposits of sand of different grades on the McCormick hills, about three miles west from Fenelon Falls. The material is sharp, and contains a large amount of limestone grains. This deposit covers about 400 acres.

The area east of Fenelon Falls along Sturgeon lake, in the townships of Fenelon and Verulam, is part of the ancient channel connecting Algonquin lake and Iroquois lake. This channel is known as Algonquin river and follows the chain of lakes in this district and the Trent valley. Numerous fluviatile deposits of sand and gravel occur along this line.

North of Burnt River, in Somerville township, the country is very sandy, and consists principally of calcareous sand originating from the weathering of the underlying limestones. The deposits extend to the south of Burnt River, where there is also some limestone gravel.

This line of deposits also occurs in Verulam township, where there are numerous beds of sand and gravel. Along the Bobcaygeon-Lindsay road several pits have been opened.

In the township of Ops a ridge of gravel west of Lindsay runs in a northeast-southwest direction and passes through lots 18, 19, 20 and 21 of concession 4. It is about one and a half miles from the town of Lindsay, and several pits have been opened upon it. The depth is generally about 10 feet. About 70 per cent. of the gravel is composed of limestone pebbles. The large stones found on top of the deposits are used for foundation work. Some sand with bonding power sufficient to make good moulding sand was found on top of this ridge.

SAND AND GRAVEL PITS IN VICTORIA COUNTY.

Owner	Township, Con. and Lot	Size in feet.	Remarks
Wm. Weese, Lindsay	Ops, Con. IV, lot 18S	150 by 60 by 10	Gravel. Reserve, 10 ac.
Patrick McGuire, Lindsay	Ops, Con. IV, lot 18N		Gravel.
Miller, Lindsay	Ops, Con. IV, lot 19		Gravel.
Patrick Murphy, Lindsay	Ops, Con. IV, lot 20		Gravel.
Lindsay Corporation, Lindsay	Ops, Con. V, lot 23		Road gravel
Grand Trunk Ry	Fenelon		Gravel.
G. H. Brandon, Fenelon Falls	Fenelon		Sand.
Fenelon Council	Fenelon, McCormick Hills	200 by 40 by 15	Sand.
R. Hawkins, Woodville	Eldon, Con. III, lot 17		Sand and gravel.
Alex. Morrison, Kinmount	Somerville, near Kinmount.		Sand.
Somerville Township	Somerville, Con. I, lot 22		Gravel.
Thos. Hodgson, Burnt River	Somerville, Con. V, lot 12	100 by 30 by 8	Sand and gravel.
John Rich, Bobcaygeon	Verulam	100 by 75 by 10	Sand and gravel. Reserve, 1 acre.
Thos. Kettle, Bobcaygeon	Verulam		Sand and gravel.
C. D. Logan, Bobcaygeon	Verulam		Sand and gravel.
R. W. Wilson, Omemee	Emily		Gravel.
McConnell, Omemee	Emily		Gravel.
Frank Duwell	Fenelon, McCormick Hills.	500 by 125 by 10	Sand.

Granular metric analysis of sand from F. Duwell's pit, McCormick hills:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	2.10	9.60	16.55	37.70	52.85	82.05	93.50	96.25	98.35

Per cent. of fineness	45.67	Apparent specific gravity	1.664
Coefficient of uniformity	44.35	Weight in lbs. per cubic foot	103.973
Grade	No. 5	Percentage of voids	41.3
Real specific gravity	2.837		

Granular metric analysis of gravel from W. Weese's pit, Lindsay:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	57.20	66.60	73.95	87.30	92.30	96.75	98.15	98.70	99.30

Per cent. of fineness	14.42
Coefficient of uniformity	66.60
Grade	No. 1

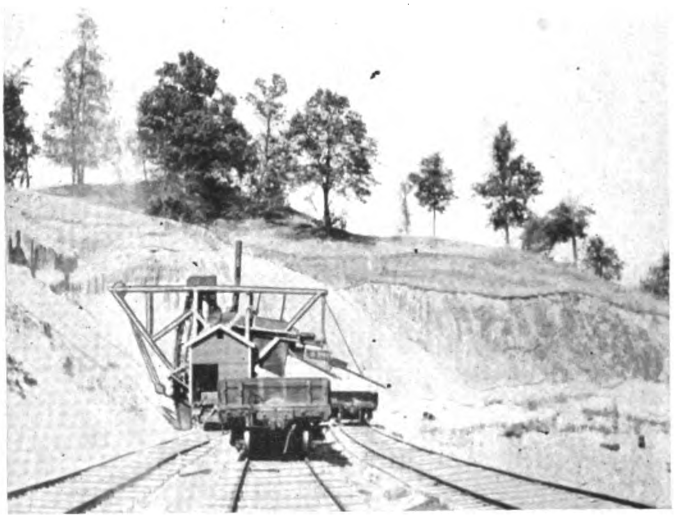


Fig. 39—Sand and Supplies, Ltd., Ayr.
View of the pit and bucket elevator.

Waterloo County

In the vicinity of Kitchener, Preston, Galt and Ayr the county is hilly, and there are several gravel ridges, a few of which have been worked. The most important pits are those of Sand and Supplies, Ltd., of Toronto, near Ayr. This

concern owns a large pit situated in a ridge of hills one and a half miles northeast of Ayr (fig. 39). The excavation covers at present a surface of 600 by 250 feet, the depth varying between 15 and 60 feet. The upper 15 feet of the high wall are gravel; under it there are sands of varying character, sometimes mingled with pebbles. At certain places 4 feet of clay occur near the top. The excavating is done by a digger elevator with buckets and screeners, producing materials of different grades. A car of 80,000 lb. capacity is filled in nearly 20 minutes.

Granular metric analysis of sand from Sand and Supplies Co., Ltd., Toronto (Ayr pit):—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.30	1.10	8.40	22.80	78.30	96.90	98.95	99.60

Per cent. of fineness	54.85	Apparent specific gravity	1.634
Coefficient of uniformity	74.10	Weight in lbs. per cubic foot ..	102.099
Grade	No. 6	Percentage of voids...........	41.4
Real specific gravity	2.791		

Welland County

Sand deposits are still in formation along the beaches of Lake Erie between Port Colborne and the mouth of the Niagara river. The material is worked on a large scale and is used for building purposes in Canada and in the United States.

Welland county lies completely south of the Niagara escarpment, on a plateau at an altitude of about 550 feet. On this plateau there are several buried channels and valleys, representing ancient connecting lines between Lake Erie and Lake Ontario. These valleys, like the present Niagara valley, were cut through the Niagara limestones and Medina shales. They are now completely filled with drift, sand, and gravel. The most important gravel pits of this county are located in these buried valleys. In such pits, irregular, oblique stratification is not rare. Gravel and sandbeds alternate, some parts of the valley being completely occupied by sand, others containing more gravel. The sand comprises a variety of grades, some parts being good sharp building material. The gravels are mostly of small limestone pebbles, with a little sandstone; the average gravel is a good auto-cementing material for concrete work. Deposits of this kind have been worked around Fonthill, Stamford, and Niagara Falls.

The concerns working in Welland county are mostly large and well equipped, this being the case both for those dredging sand out of Lake Erie and those working gravel pits. The material is sold at about 50 cents a yard. Some moulding sand is found on top of the buried valleys.

SAND AND GRAVEL PRODUCERS, WELLAND COUNTY

Owner	Location	Size in feet.	Output.	Remarks
Confederation Sand and Gravel Co., St. Catharines........	Mouth of Niagara R..	....	100,000 yd.	Sand dredged out of Lake Ontario
Empire Limestone Co., Buffalo...........	Lake Erie shore.....	....	100,000 yd.	Sand dredged out of Lake Erie..
Conlon, St. Catharines	Fonthill	180 by 90 by 40 100 by 120 by 40	....	Two pits. Sand and gravel.
Clifton Sand and Gravel Co., Toronto.	Stamford...........	450 by 600 by 75	....	Sand. Reserve, 50 acres.
Ontario Sand Co., Niagara Falls	Stamford tp.........	300 by 400 by 15	12,000 yd.	Gravel and sand. Reserve, 39 acs.
Stamford Sand Co., Niagara Falls.....	Stamford tp	500 by 300 by 75	....	Sand and gravel.
Standard Gravel Co., Niagara Falls.....	Stamford tp	200 by 200 by 15	Daily output in 1917, 100 yds.	Sand and gravel. Reserve, 6 ac.

Granular metric analysis of sand from the Ontario Sand Co.'s pit, Niagara Falls:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained....	13.0	20.45	25.50	49.60	68.85	90.05	94.95	96.25	97.75

Per cent. of fineness	38.2	Apparent specific gravity	1.743
Coefficient of uniformity	43.35	Weight in lbs. per cubic foot ..	108.910
Grade	No. 4	Percentage of voids	38.8
Real specific gravity	2.847		

Granular metric analysis of gravel from the Standard Gravel Co.'s pit, Niagara Falls:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained ...	35.35	45.75	50.85	61.65	70.75	93.40	98.20	98.85	99.35

Per cent. of fineness	27.3
Coefficient of uniformity	45.75
Grade	No. 1

Wellington County

The pits examined in this county were near Guelph and Erin. In the southern part of Guelph there is a ridge about 100 feet west of the Waterloo road, containing road and cement gravel, moulding sand, brick sand, and building sand. This deposit extends over a large area, and important reserves are still available. In one of the pits there were about 20 feet of sand on top, over the gravel; and borings have shown

this gravel to be 80 feet in thickness, overlying the limestone. The sand, which shows oblique stratification, is of good quality for making mortar and for other building purposes. In some places there are 4 feet of moulding sand. This material is valuable, and is sold at $2.50 a yard, while gravel and ordinary sand sell at $1.50 per yard, delivered in Guelph.

The amount of gravel and sand found in the neighbourhood of Erin is very large, and some important concerns are now in operation. The gravel, which usually contains 60 per cent. pebbles and 40 per cent. sand, is screened to provide different grades. The large pebbles are sometimes crushed to produce finer material.

SAND AND GRAVEL PRODUCERS IN WELLINGTON COUNTY.

Owner	Location	Size in feet	Output	Remarks
Agnes Haggerty, Guelph	Waterloo Rd., Guelph	15 by 10 by 12	....	Gravel pit opened in 1916.
A. McCannell, Guelph	Waterloo Rd......	150 by 150 by 20 150 by 75 by 15	2,000 yd.	Gravel pit. Sand pit. Reserves, 40 acres.
Dr. Gear, Erin	Erin tp., Con. X, lot 15	75 by 60 by 12	350 yd.	Gravel and sand sold at 10c. per yd. at the pit.
Rocsand Co., Erin..........	Erin tp., Con. X, lot 16	500 by 350 by 20	Daily output in 1917, 300 cu. yd.	Gravel and sand, steam shovel and screening plant. Reserve, 20 acres.
C. P. Ry., Erin	Erin tp., Con. X, lot 16	1,000 by 200 by 15	....	Ballast.
Construction and Paving Co., of Ont., Toronto.	Erin tp., Con. XI, lot 15	300 by 100 by 18	8,500 yd.	Gravel and sand.
J. Hamilton, Erin	Erin tp., Con. X, lot 15	Depth, 35 ft. gravel	Not worked	Gravel and sand. Reserves, 40 acres.

Granular metric analysis of sand from Rocsand Company's pit, Erin:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.35	2.65	5.95	18.65	41.20	92.45	97.20	98.05	98.80

Per cent. of fineness	49.4	Apparent specific gravity	1.636
Coefficient of uniformity	73.80	Weight in lbs. per cubic foot ..	102.22
Grade	No. 5	Percentage of voids	44.2
Real specific gravity	2.935		

Granular metric analysis of gravel from Rocsand Co., Erin:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	57.85	67.40	72.10	81.10	88.90	97.85	99.30	99.50	99.70

Per cent. of fineness	15.14
Coefficient of uniformity	67.40
Grade	No. 1

Wentworth County

This county, with Hamilton as its principal city, is crossed by the shoreline of ancient Lake Iroquois (fig. 40). This shoreline is located at an average of about two and a half miles inland from the present shore of Lake Ontario, and lies close to and parallel with the Niagara escarpment. Several deposits of sand and gravel occur along this line, and are valuable sources of supply for Hamilton.

In the region south of Bartonville, in the townships of Saltfleet and Barton, moulding sand occurs as a surface deposit, and this material is used in the foundries of Hamilton and of Ontario in general. All grades of moulding sand, from very fine brass sand to coarse pipe sand, have been found in this region.

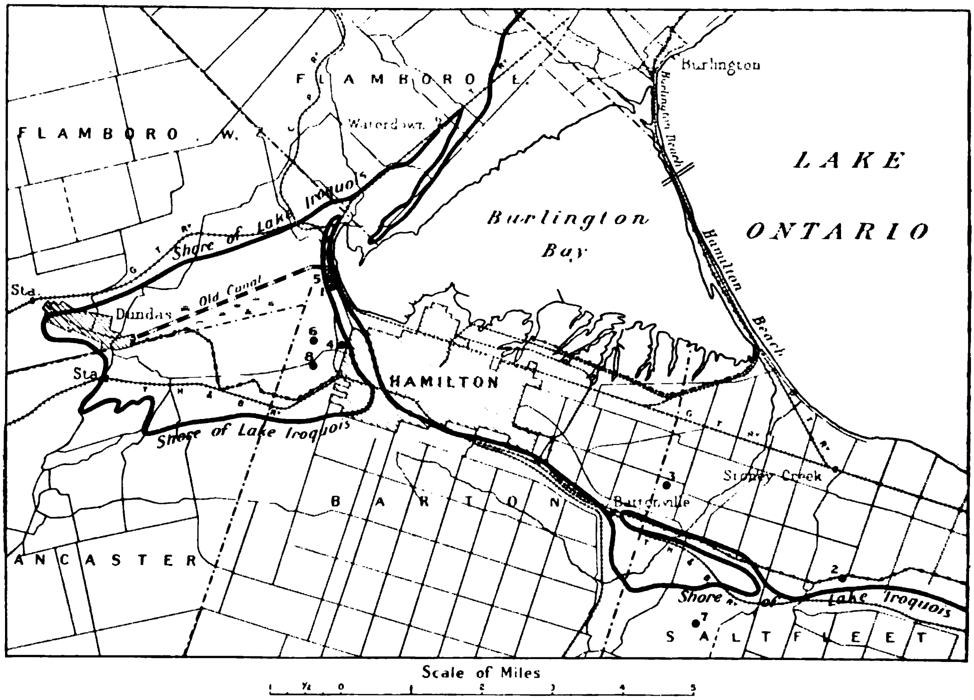


Fig. 40—Map of Hamilton and vicinity, showing location of the principal sand and gravel deposits, also the shore line of ancient Lake Iroquois. Numbers refer to the list given in the text.

There are also very large deposits west of Hamilton, on the area covered by the ancient bay that terminated Lake Iroquois to the west. These deposits, which at some places consist of alternate layers of clay, sand, and gravel, have been largely worked by brick plants.

Some layers of gravel are cemented by calcite; others consist of sandy gravel, from which by crushing the larger boulders and screening, the following products are obtained: coarse gravel, medium gravel, crushed stone for roadwork, pea gravel for concrete, medium sand, brick sand, and core sand. At the Armstrong Supply Co.'s pit at Hamilton, for instance, there are about 160 feet of gravel and sand before the water level is reached. The screening diagram of this concern indicates how the material is prepared for the market (fig. 41).

A large sandbar extends east of Hamilton in a north-south direction across Burlington bay, connecting Hamilton and Burlington. The southern part is known as Hamilton beach, the northern as Burlington beach. This bar is covered by cottages, railways, etc., and forms an important natural bridge. It is controlled by the Burlington Beach Commission. A little sand has been taken out of the lake in the neighbourhood. The average material sells at prices ranging from 70 cents to one dollar a yard at the pit. Moulding sand is sold at about one dollar per ton.

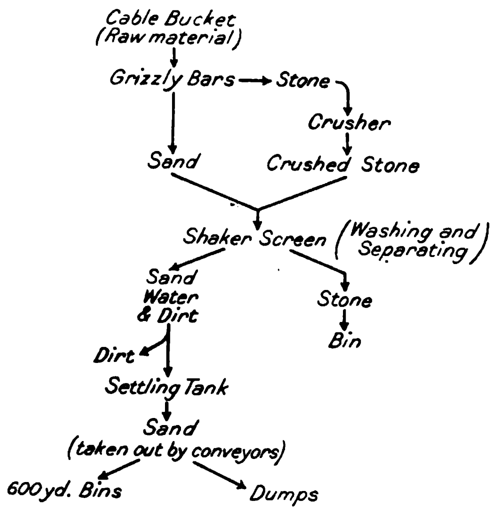


Fig. 41—Screening diagram of Armstrong Supply Co., Hamilton.

SAND AND GRAVEL PRODUCERS, WENTWORTH COUNTY.

No.	Owner	Location	Size in ft.	Output	Remarks.
1	Armstrong Supply Co., Hamilton.....	Western end of Burlington bay	Depth of pit, 80 ft.	....	Sand and gravel. Reserves, 18 ac.
2	W. Barnes, Hamilton	Stoney Creek	....	....	Gravel and some moulding sand.
3	Barton Sand & Gravel Co., Bartonville ..	Barton tp., Con. III, lot 1	30 deep	8,000 yd.	Sand & gravel, Plant of 400 yds daily capacity. Reserve, 12 ac. (fig. 42)
4	Geo. Frid Brick Co., Hamilton.........	Northwest of Hamilton	50 by 50 by 30	20yd. per day	Sand and gravel. (fig. 43)
5	Hamilton Sand and Gravel Co., Hamilton.	Junction Cut, Hamilton	350 by 150 by 40	60 yd. per day (10,000 yds)	Gravel and sand. (fig. 44)
6	Ollmann Bros., Hamilton.........	Northwest end of Hamilton, near Dundas Road	500 by 300 by 40	2,000 yd..	Sand and gravel. Reserve, 8 ac.
7	O. Quigley, Hamilton	Saltfleet tp., Con. IV and V, lot 30......	Depth, 6 ft.	10,000yd..	Moulding sand. Reserve, 75 ac.
8	R. Tope, Hamilton ..	Dundas Rd., Barton tp. Con. II, lot 20	100 by 50 by 30	....	Gravel (fig. 45)

Chemical analysis of pipe moulding sand, O. Quigley, Hamilton:—

	Per cent.
Silica (SiO_2)	80.42
Iron (Fe)	0.05
Iron oxide (Fe_2O_3)	5.423
Magnesia (MgO)	1.48
Alumina (Al_2O_3)	5.10
Lime (CaO)	3.12
Carbon dioxide (CO_2)	4.05
Total	99.643

Fig. 42—Barton Sand and Gravel Co's. pit, Bartonville.

Chemical analysis of machinery moulding sand, Quigley pit, Hamilton:—

(Analysis by W. K. McNeill, Provincial Assayer.)

	Per cent.
Silica	74.42
Alumina	10.37
Ferric oxide	2.61
Ferrous oxide	2.22
Lime	2.76
Magnesia	1.08
Potash	1.72
Soda	2.36
Water	1.65
Carbon dioxide	1.00
Total	100.19

The bonding power of this material is due to the high percentage of alumina and iron oxides.

Norm calculated from the preceding analysis:—

Calcite		2.30	
Orthoclase	10.01		
Albite	19.91	37.15	feldspars
Anorthite	7.23		
Corundum		2.04	
Magnetite		3.71	
Enstatite		2.70	
Grünerite		1.98	
Quartz		48.60	
Water		1.00	
Total		99.48	

The corundum and magnetite indicate the presence of kaolinite or clay mixed with iron oxides, the cause of the moulding qualities of the sand.

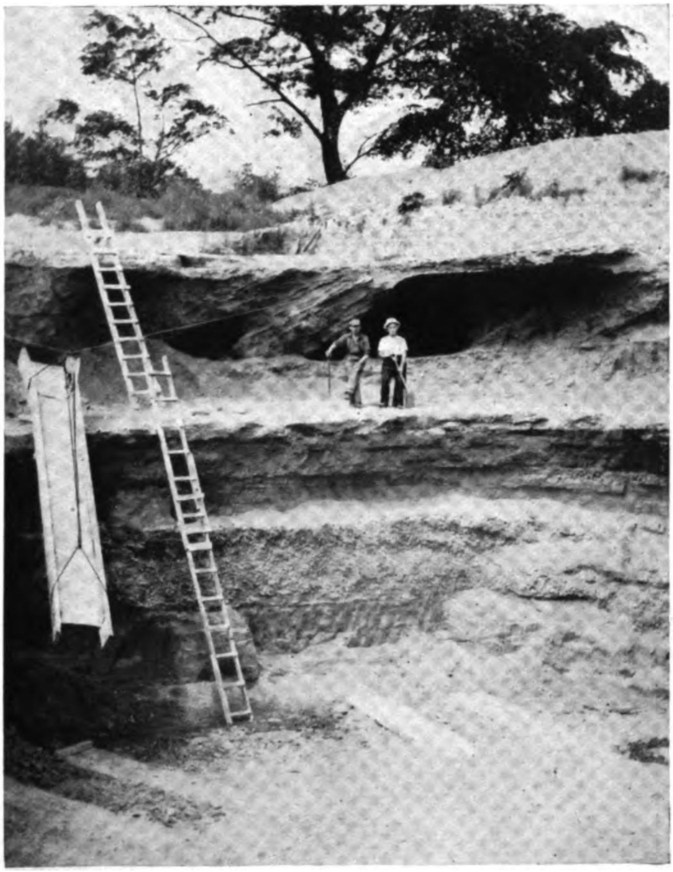


Fig. 43—Frid gravel pit, Hamilton.

Fig. 44—Hamilton Sand and Gravel Co's. pit and screening plant.

Fig. 45—Tope gravel pit, Hamilton.

Granular metric analysis of washed sand from Armstrong Supply Co., Hamilton:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.05	4.95	10.00	24.30	32.05	68.05	94.00	98.60	99.10

Per cent. of fineness	52.10	Apparent specific gravity	1.645
Coefficient of uniformity	61.95	Weight in lbs. per cubic foot ..	102.786
Grade	No. 6	Percentage of voids	42.1
Real specific gravity	2.841		

Granular metric analysis of sharp sand from Hamilton Sand and Gravel Co., Hamilton:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.20	0.70	1.45	4.05	11.75	71.75	97.55	99.25	99.60

Per cent. of fineness	57.08	Apparent specific gravity	1.511
Coefficient of uniformity	85.80	Weight in lbs. per cubic foot ..	94.413
Grade	No. 6	Percentage of voids	48.4
Real specific gravity	2.933		

Granular metric analysis of pea gravel, from Armstrong Supply Co., Hamilton:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	89.60	99.85	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Per cent. of fineness	1.17
Coefficient of uniformity	99.85
Grade	No. 1

York County

The shorelines of Lake Algonquin and Lake Iroquois which pass across this county are rich in deposits of gravel and sand. From an economic standpoint, the deposits of the Lake Iroquois beach are the more important, on account of their proximity to the city of Toronto. The whole area between the Iroquois shoreline and Lake Ontario is covered by Iroquois beach materials, principally sand (fig. 46).

The greater part of Toronto lies on Iroquois sand, and while some large pits are still working inside the city limits, most of them are nearing exhaustion, as the surrounding buildings prevent the extension of the worked area.

On the southern side of Bloor street west, about 250 yards west of Dundas street, there is an outcrop of sand, 10 feet above the street level. Under the soil there are 3.5 feet of moulding sand, then a small gravel bed, and under it ordinary Iroquois building sand.

West of Toronto, and about two miles east of the Humber river, there are some small gravel and sand pits.

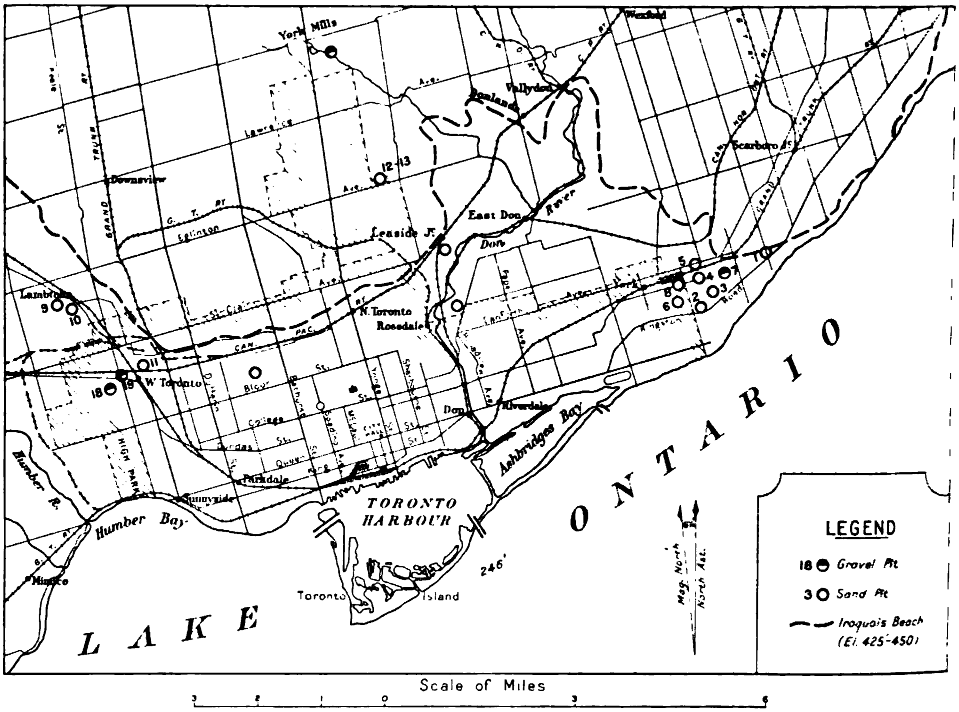


Fig. 46—Toronto and vicinity, showing location of principal sand and gravel pits. The numbers refer to the list given in the text.

Most of the sand and gravel supply of Toronto comes from the suburbs and from the surrounding district. Large sand and gravel bars were formed during Iroquois times east and west of the present city limits; the eastern bar, which is the more important, passes through York and Birch Cliff, while the western bar passes near West Toronto station and Lambton Mills. These bars were built up in the same way as Toronto Island is now being formed. This recent bar is not worked, the island being used as a summer resort.

In the Iroquois bars there are numerous pits of sandy gravel, which when screened produces four sizes.

(1) Sand used for polishing glass and marble; grains passing the 4-mesh screen.

(2) Gravel for roofing; pebbles passing the 2-mesh screen.

(3) Gravel for reinforced floors and concrete work; pebbles three-quarters of an inch in diameter.

(4) Gravel for road and general foundation work, pebbles between 1 inch and 3 inches.

The gravel bar is underlain by Iroquois sand. Where the Iroquois sand is the top deposit, the upper parts are generally brown, exhibiting bonding power, and at certain places this sand is a moulding sand or a core sand.

The pits are numerous on the north side of Kingston road, and some pits (York Sand and Gravel Limited) produce as much as 100,000 tons a year, half of this material being sand. The mortar sand sells at 25 to 40 cents a yard, sharp sand at about 40 cents, and screened gravel at $1.00 at the pit. As one team can make only two trips a day from the pit to Yonge street, the transportation costs are very high, so that pea gravel costs as much as $2.30 a yard, delivered at Yonge street.

One gravel pit was worked in Summerville, about ten miles west of Toronto. The gravel was brought to the city by motor trucks of 4.5 cubic yards load, making 5 trips daily. This considerably reduced the cost of transport, the cost of an ordinary team being about $6.75 per day.

The run of gravel of the Iroquois bar formation is used by the York Sandstone Brick Co. for making sand-lime bricks. The sandy gravel is screened to eliminate the large stones, and then mixed with 6 to 9 per cent. of slacked lime. This mixture is passed through a Chilean mill crusher, and then into moulding presses, from which the bricks are loaded on wagons, run into big tanks, and submitted for twelve hours to a steam pressure of 125 to 135 pounds. After this time, the bricks are white and hard. It is claimed that these bricks become harder as they advance in age, this phenomenon being probably due to the chemical action of the carbon dioxide of the atmosphere.

Northeast of Toronto, there are some gravel and sand formations near Leaside Junction, where recent gravel is found in the bed of the Don river; also near Aurora, where moulding sand which has been used in the foundry at Aurora, and building sand occurs over a large area. The area between Aurora and Bond lake is very sandy, and contains large reserves. At Maple, four miles west of Yonge street, in lots 22 and 23, concession three of Vaughan township, there are two operators, supplying large quantities of building sand and gravel to Toronto. This material is sold at about 70 to 80 cents a ton in Toronto, of which 55 cents is consumed in freight charges.

SAND AND GRAVEL PRODUCERS, YORK COUNTY.

No.	Owner	Location	Size	Output.	Remarks
1	Allen Bros., Toronto	Birch Cliff, Scarboro tp	5 acres. 25 ft. gravel, 8 ft. sand	1,500 yd.	Sand & gravel. Screen moved by horse-gear.
2	Bourne & Son, Toronto	Scarboro tp., Kingston Rd			Sand and gravel.
3	E. Ashton, 1352 Queen St. E., Toronto	Scarboro tp., Victoria Park Rd			4 kinds of sand and gravel.
4	York Sand and Gravel Co., Toronto	Scarboro tp. south of G.T.Ry	Gravel. 25 ft. deep. Iroquois sand more than 100 ft. deep	95,000 tons	Pit run gravel, screened gravel, mortar, sand and brick sand. Steam shovel of 1,200 tons daily capacity.
5	York Sandstone Brick Co., Toronto	Scarboro tp., South of G.T.Ry			Sand and gravel for sand-lime brick making.
6	John Foley, 196 Pickering St., Toronto	Toronto City, east of Pickering St. and north of Kingston Rd	8 ft gravel		Gravel and Iroquois sand.
7	Jackson, 183 Pickering St., Toronto	Toronto City, east of Victoria Park Rd		Small	Gravel.
8	J. McTague, Malvern Road, Toronto	East Toronto, north of Kingston Rd. and east of Pickering St.	8 ft. gravel	4 yd. a day	Gravel and sand.
9	Maher, Wm., Weston	Weston Rd., Mt. Dennis	35 ft. deep	40 yd. a day	Principally sand.
10	Thompson, Porter, 26 Porter Ave., Mt. Dennis	Mt. Dennis			Sand and gravel.
11	Lochrie, Keele St. and Westminster Ave., Toronto	Toronto			Sharp sand.
12	H. L. Johnson, 56 Soudan Ave., Toronto.	North of Eglinton, Ave. and 1 mile east of Yonge St.			Sand and a little gravel.
13	A. J. Rayner, 244 Broadway Ave., Toronto	North Toronto			Sand.
14	Jos. Billing	Aurora, 1 mile west of Yonge St.			Moulding sand.
15	The Empire Sand and Gravel Co., Maple	100 yds northeast of Maple station	750 ft. long, 30 ft. deep		Building sand and gravel.
16	Maple Sand, Gravel and Brick Co., 178 Spadina Av., Toronto	500 yards north of Maple station	100 ft. deep	40,000 tons	Sand and gravel. Reserve, 80 acres. Steam shovel and steam screen.
17	Frank Pringle, 309 Indian Grove, Toronto	Summerville, 10 miles west of West Toronto	16 ft. deep		Gravel. Reserve, 25 acres. Motor trucks used in transportation.
18	Niagara Power Plant	West Toronto	8 ft. deep		
19	Home Smith Co., Toronto	Keele St., W. Toronto			Gravel.
20		Toronto, Shaw St.			Interglacial sand and gravel.

Granular metric analysis of Iroquois sand, near corner of Gerrard Street and Greenwood Avenue, Toronto:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.03	0.09	0.24	0.39	8.49	71.99	89.49	98.09

Per cent. of fineness	70.13	Apparent specific gravity	1.414
Coefficient of uniformity	81.00	Weight in lbs. per cubic foot ..	88.352
Grade	No. 7	Percentage of voids	52.1
Real specific gravity	2.953		

Granular metric analysis of sand from lake shore, Toronto Island:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	0.0	0.40	4.75	76.85	98.50	99.60	100.00

Per cent. of fineness	57.77	Apparent specific gravity	1.721
Coefficient of uniformity	93.75	Weight in lbs. per cubic foot ..	107.535
Grade	No. 6	Percentage of voids	44.3
Real specific gravity	3.093		

Granular metric analysis of sharp sand from interglacial beds, Shaw street, Toronto:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	1.25	2.35	5.80	12.65	67.30	92.85	96.65	98.70

Per cent. of fineness	58.05	Apparent specific gravity	1.585
Coefficient of uniformity	80.20	Weight in lbs. per cubic foot ..	99.037
Grade	No. 6	Percentage of voids	44.3
Real specific gravity	2.844		

Granular metric analysis of coarse sand, Bourne and Son, Toronto:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	tr.	0.30	0.70	9.55	62.90	84.35	95.60

Per cent. of fineness	71.84	Apparent specific gravity	1.654
Coefficient of uniformity	74.80	Weight in lbs. per cubic foot ..	103.349
Grade	No. 7	Percentage of voids	44.8
Real specific gravity	2.997		

Granular metric analysis of sand, upper part, Aurora deposit:—

Mesh	4	8	10	20	28	58	80	100	200
Per cent. retained...	0.0	0.0	0.0	0.0	tr.	tr.	0.20	2.30	31.35

Per cent. of fineness 96.24
Coefficient of uniformity 97.70
Grade .... No. 9
Real specific gravity 3.230
Apparent specific gravity 1.581
Weight in lbs. per cubic foot .. 98.787
Percentage of voids 51.05

Granular metric analysis of sand, central part, Aurora deposit:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.0	0.0	tr.	tr.	tr.	0.30	10.10	28.60	58.60

Per cent. of fineness 89.16
Coefficient of uniformity 71.40
Grade .... No. 9
Real specific gravity 3.036
Apparent specific gravity 1.667
Weight in lbs. per cubit foot .. 104.161
Percentage of voids 45.1

Granular metric analysis of gravel, Allen Bros., Birch Cliff:—

Mesh	4	8	10	20	28	48	80	100	200
Per cent. retained...	0.35	40.25	64.50	86.70	93.05	96.75	97.45	97.95	98.85

Per cent. of fineness 24.90
Coefficient of uniformity 64.15
Grade .... No. 2

APPENDIX

Introduction

The following brief report on certain northern Ontario sand and gravel deposits, with the exception of the part dealing with granular metric analyses, was compiled by Prof. A. L. Parsons, of Toronto University, from the notes taken by Professor Ledoux during that part of the field season of 1918 prior to his decease on August 7th.

Granular metric analyses of thirty different samples of sand and gravel, as shown in the table accompanying this appendix, were carried out by H. E. Davis, who is in charge of testing road materials for the Ontario Department of Public Highways. P. A. Jackson, of the Bureau of Mines staff, assisted in the tests. Mr. Davis reports as follows in regard to the methods used:

Specific Gravity of Sand.—The specific gravity was determined by the use of Le Chatelier's specific gravity apparatus, consisting of a flask having a large bulb at the bottom tapering up to a narrow bulb which has a narrow neck of about ¼ inch. The flask is filled with water up to a mark on the lower section of the flask, the distance between this mark and the lower point on the graduations on the upper part of the flask is 20 cc., the narrow neck being graduated into tenths of cubic centimeters. A sample weighing 60 grams was then slowly introduced into the mouth of the flask and the displaced volume recorded.

$$\text{Specific gravity} = \frac{\text{Weight of sand}}{\text{Displaced volume}}$$

Tyler Standard Screens.—For some considerable time there has been a demand for standard testing screens with accurately measured openings that increase or decrease through the series of screens in a fixed ratio. The manufacturer of this screen has established, as a minimum standard, the 200-mesh commercial sieve which has been made of wire .0021 of an inch and having openings of .0029 inch. The scale ratio between the different sizes of screen opening has been taken as 1.414 or the square root of 2, as recommended for ore dressing. Taking .0029 inch, which is the opening of the 200-mesh screen, as the base, the diameter of each successive opening is exactly 1.414 times the opening in the previous screen. It also makes the area or surface of each successive opening on the scale just double that of the next finer or half that of the next coarser screen. In other words, the diameters of the successive sizes are in a ratio of 1.414 while the areas of the successive openings have a constant ratio of 2.

Methods used in conducting Granular Metric Analysis of Sand.—Having thoroughly mixed the samples submitted for test, a quantity of the sand[1] was weighed out and placed on the coarsest screen under which were placed in order the finer screens. The nest of screens was then submitted to a mechanical agitation for about 10 minutes. Screens were then removed and the sand on the coarsest was weighed and recorded. To this was added the sand on the next coarsest screen and the total weight recorded, giving the cumulative weight retained on each screen. To express this in total per cent. retained on any one screen the following formula is used:—

$$\frac{W}{W'} \times 100 = \text{per cent. retained on screen.}$$

where W = total weight of sand before agitation.
and W′ = cumulative weight of sand retained on screen.

[1] Sand, as distinguished from gravel, is defined as that part which passes through a ¼-inch screen.

GRANULAR METRIC ANALYSES OF SAND CONTENT OF CERTAIN SAND AND GRAVEL DEPOSITS IN NORTHERN ONTARIO.

District	Description and location of deposits	Laboratory No.	Per cent. retained on Tyler standard screens								Real specific gravity	Per cent. of fineness
			8	10	20	28	48	80	100	200		
Parry Sound...	Parton pit, Parry Sound	15	9.3	17.9	50.7	77.3	96.0	99.9	100.0	100.0	2.69	31.1
" " ...	Beach sand, northwest of Kill Bear point, near Parry Sound............	16	......	......	2.3	27.5	48.2	99.8	99.9	99.9	2.62	52.8
Nipissing......	Beach sand, Lake Nipissing, 3 miles south of North Bay.................	17	......	......	......	......	11.2	92.0	99.0	99.9	2.69	62.2
"	Bordeleau gravel and sand pit, 2 miles east of Sturgeon Falls	18	13.5	19.7	34.8	46.4	74.6	90.9	95.6	98.4	2.74	40.8
"	Lakeview Park, North Bay, gravel on beach, in front of cottage of Judge Leach	19	2.2	28.9	98.0	99.7	99.7	99.8	99.8	99.8	2.62	21.5
"	Beach sand, Lake Nipissing, south of Sturgeon Falls	20	1.8	4.4	20.3	60.4	98.6	99.1	99.4	99.6	2.61	39.5
"	Gravel pit, Tomiko, mileage 25, T. & N. O. railway	†29	10.9	19.0	47.5	71.7	92.6	97.1	98.2	99.0	2.70	33.0
	Gravel pit, Rabbit Creek, mileage 58.5, T. & N. O railway	*28	21.6	39.2	68.5	81.7	93.0	96.4	97.9	99.3	2.70	25.3
Timiskaming...	Sand, Martineau bay, Lake Timiskaming.	30	......	.1	2.7	16.6	97.9	99.8	99.9	99.9	2.67	47.9
" ...	Sand, Chambers-Ferland pit, Cobalt....	27	.1	.2	2.3	7.3	40.8	70.1	84.2	95.8	2.67	62.4
" ...	Sand near Nellie Lake station	2	......	......	.05	.1	3.5	36.1	69.4	93.2	2.68	74.7
" ...	Nellie Lake pit, T. & N. O. railway, sandy gravel	4	......	.05	2.7	17.5	72.7	94.0	99.1	99.8	2.65	51.8
" ...	Nellie Lake ballast pit, fine gravel at bottom of pit	*7	18.5	35.2	78.2	96.8	99.4	99.5	99.5	99.5	2.67	21.7
" ...	Fine sand, Cochrane..................	9	......	......	......	.1	.4	3.0	12.0	55.3	2.73	91.1
" ...	Gravel from ballast pit, 2 miles south of Cochrane	5	19.9	34.9	63.7	79.6	91.9	95.0	95.9	96.8	2.67	27.8
" ...	Sand at south end of ballast pit, 2 miles south of Cochrane	11	.1	.3	3.9	19.9	82.8	97.7	99.3	99.6	2.67	49.5
" ...	Sand, road west of Timmins	24	......	.1	.15	.2	.4	8.4	39.1	82.3	2.64	83.7
" ...	Sand, east of Timmins	21	1.0	2.1	6.3	14.6	58.7	89.9	96.7	99.5	2.69	53.9
" ...	Gravel, east of Timmins	25	9.6	15.2	33.2	53.2	91.1	98.5	99.3	99.4	2.65	37.6
" ...	Coarse sand, east of Timmins	26	.9	2.7	10.2	22.1	71.5	95.0	98.1	99.3	2.65	50.0

GRANULAR METRIC ANALYSES OF SAND CONTENT OF CERTAIN SAND AND GRAVEL DEPOSITS IN NORTHERN ONTARIO.—*Continued.*

District	Description and location of deposits	Laboratory No.	Per cent. retained on Tyler standard screens								Real specific gravity	Per cent. of fineness
			8	10	20	28	48	80	100	200		
Timiskaming..	Drinkwater pit, Porcupine branch, T. & N O. railway	22	.8	1.2	2.0	3.5	20.0	56.7	82.2	94.5	2.63	67.4
" ...	Barber Bay, pit near the track, Porcupine branch, T. & N. O. railway......	*23	24.9	38.1	60.7	75.9	92.9	96.9	98.0	99.9	2.69	26.6
" ...	Town of Cochrane gravel pit, located 1 mile north of town	*3	6.4	13.5	41.7	64.3	93.3	98.8	99.8	99.8	2.61	35.3
" ...	Sand from pit, 1 mile north of Cochrane, near pumping station	8	.05	.07	.1	.2	6.1	52.0	82.8	97.5	2.65	70.1
" ...	Buskego, Canadian National Railway, mileage 9, west of Cochrane	6	4.1	8.7	28.6	49.0	90.4	96.7	97.7	98.5	2.65	40.8
" ...	Coarse sand, Buskego pit, west of Cochrane	1	·3	.5	2.1	7.3	68.6	95.2	97.9	98.6	2.70	53.7
" ...	Gravel pit, 1 mile south of mileage 57, near Moonbeam, Can. Nat. Ry.	13	10.3	27.3	72.0	90.4	99.7	99.9	99.9	99.9	2.69	25.1
Algoma........	Gravel hill, 4 miles west of Hearst, Can Nat. Ry.	*10	9.0	22.6	64.2	79.4	88.9	92.9	94.7	97.0	2.62	31.4
"	Coarse sand, 4 miles west of Hearst....	12	......	.2	18.4	65.1	95.7	98.8	99.4	99.9	2.55	40.3
"	Moulding sand on top of hill 4 miles west of Hearst	14	......	....	.1	.2	.7	1.2	3.4	18.9	2.69	96.9

*Material suitable for concrete work.

†Quartz and feldspar grains from disintegrated gneiss predominate.

Parry Sound District

The district as a whole is very rocky, the outcrops being mostly granite, gneiss and other related pre-Cambrian rocks. The glacial Lake Nipissing once extended over this whole region, the smaller lakes at present scattered through the district being the remnants of the large lake after the water level had been lowered.

Deposits of gravel, sand and clay were laid at various depths in these waters and some of them are still found on the slopes of the hills.

Several deposits may be noticed in the vicinity of the town of Parry Sound. One mile north of the town there is a ridge of sand and gravel running north 45° east, mostly on the west side of the road. The graveyard is located on part of it.

Argue's sand pit, Parry Sound.

The length of the ridge is about 800 yards and the width 200 yards. Several pits located on the properties of Messrs. Argue, Parton and Reece Hall have been opened in this ridge.

Argue's pit is located just north of the cemetery, on the west side of the road, the excavation being 75 by 36 by 12 yards. The material is mostly sand, well suited for building purposes, the deposit showing oblique stratification. The north portion of it contains more pebbles and grades into a gravel. Some large boulders are found. As a rule the pebbles are granite and gneiss, although sometimes an odd pebble of limestone is found. The sand is coarse and contains quartz as its principal constituent. Feldspars and dark ferro-magnesian mineral grains are also abundant.

The deposit lies about 100 feet above the level of the Seguin river or 700 feet above sea level. This material is sold at about 40 cents a load at the pit. The reserve is 125,000 cubic yards approximately.

Parton's pit lies 500 yards to the north, on the east side of the road, in lot 28, Con. II, of McDougall township. Both sand and gravel occur, with gravel predominating in some parts. The present excavation is 40 by 20 by 10 yards in size, the reserves being 20 acres in area, mostly all gravel. If the average depth is calculated at ten yards, the available material would total 48,400 by 20 = 968,000 cubic yards. The output in 1917 was about 2,000 cubic yards, this material being sold at 15 cents for road gravel and at 25 cents for average cement gravel. The gravel is of good quality, most of the pebbles being of granite and other pre-Cambrian rocks, and very few of limestone. The deposit lies at an altitude of about 740 feet[1] above sea level.

Reece Hall's pit is located east of Parton's, and a little south of Mill lake. The excavation measures 60 by 12 by 10 yards, and lies at about the same level as the Parton pit. The east side of this gravel pit shows rock outcrops.

Four miles north of Parry Sound, on the east side of the northern road, there is a small sand and gravel pit 30 by 15 by 3 yards in size, located on a ridge crossing the road in an east and west direction. The pit belongs to John Draper.

One mile north of Waubamick station, on the C. N. Ry. line, there is a large pit containing mixtures of sand, clay and gravel. The material is used as ballast for the railway, and the present excavation is 400 by 150 by 12 yards, corresponding to a removal of 720,000 cubic yards. The pit has been idle for several years, but is to be worked again. The necessary equipment, including steam shovels, has been provided, and the railway company intends to take out during the summer of 1918 approximately 60,000 cubic yards. This deposit lies 850 feet[1] above seal level.

Another pit on the same large deposit of sand and gravel, but farther east, will be opened about one mile northeast from Waubamick station. This material is to be used principally for filling work.

The deposits around Waubamick lake were probably formed in an old bay or tributary of Long lake. The deposits near Parry Sound graveyard were formed by Mill lake, while the ridge on which J. Draper's pit is located is connected with a former stage of the history of Portage lake.

On the shore of Georgian bay and on the numerous islands located in Parry Sound the deposits of sand and gravel are few in number and as a rule of small extent. Between 2-Mile point and 3-Mile point there is a small sand beach about 75 yards long, the result of weathering of the rocks of Parry island. There are two little sand beaches about 30 yards wide near the lighthouse at 3-Mile point on Parry island. At Kill Bear point, about 200 yards east of the lighthouse, there is a sand beach about 100 yards long.

Northwest of Kill Bear point there is a large sandy beach extending around the bay in Con. VIII, McDougall township, for about 1,500 yards, but in no place wider than 200 yards. The sand contains numerous clear transparent quartz grains, some feldspar and brown ferro-magnesian minerals. There is only a narrow strip near the shore not covered by vegetation.

[1] Aneroid determination.

Sandy island, located in Georgian bay, about three miles from Parry island, is composed entirely of sand, with some large pebbles along the southeastern shore and smaller pebbles along the northern shore. This island has an area of about 1,000 acres, and is covered with wood, but contains a large reserve of sand resulting from the weathering of granitic and gneissoid rocks. The average elevation of the island is not more than 60 feet above Georgian bay. Black mineral grains and vegetable matter are intermixed with the sand. All round the island the water is very shallow for about 500 yards from the shore. Large quantities of material are recoverable by dredging. The sand at Sandy island is of a finer size than the sand of Kill Bear point, where it is coarse and whiter. The upper part of the Sandy island deposit looks white when dry, but it contains ferruginous elements, and as soon as digging is done black and brown sand are found. This island belongs to Walter L. Haight, Parry Sound.

There is a sandpit along the Canadian Pacific railway tracks near Shawanaga station, and also between Parry Sound and Byng Inlet, along the shore of Georgian bay. Small pockets of sand overlaid by mud are found in the bay opposite Franklin island, on Shebeshekong beach. Further north the islands in Georgian bay are more and more rocky.

Along the road through the bush from Parry Sound to Rose Point small deposits of angular gravel occur, resulting from the disintegration of underlying diabases, pegmatites and gneisses. Large quantities of poor sand were excavated for ballast at Depot Harbour on Parry island, in the cuttings of the Grand Trunk railway, near James bay junction and at Otter lake. This material is very often ferruginous, brown in colour and contains a certain amount of silt and angular fragments of the underlying rocks.

Near Whitehall and Sprucedale, in concessions X and XI of McMurrich township, local deposits of sand and gravel are not uncommon. East of Whitehall station, a large excavation, 15 feet deep, was made along the G. T. railway tracks for ballast supply. The sand is very often brown, due to vegetable matter from resinous trees which it contains.

There are also some deposits and excavations between Sprucedale and Scotia Junction. The country between Scotia Junction and Kearney along the G. T. railway is very sandy, and several railway cuts pass through deposits 25 feet in thickness. The adjoining territory in Bethune township is covered by a sandy soil, which has been used to some extent for railway ballast.

Near Ravensworth, the last station on the G. T. railway in Parry Sound district, the altitude rises to 1,400 feet, and small local sand pockets are found at this level. An excavation 800 by 100 by 37 yards has been made along the tracks for supplying ballast.

Between Scotia Junction and Burks Falls there is a great alluvial plain made mostly of sand and silt. Near Emsdale, at Burk's Falls, and at other local occurrences, the quality of this material is better, and it has been worked for sand or road gravel. The proportion of clay is, as a rule, too great, and on the roads this material is soon reduced to dust.

About one mile northwest of Burks Falls there is a sandy ridge at an altitude of 680 feet above sea level. The ridge is made of sharp sand, except at the

surface of the deposit, where it is mixed with clay and pebbles. At Carss station there is also some sandy material lying 675 feet above sea level (aneroid measurement).

At mile 172, on the G. T. railway, near Burks Falls, a gravel ridge crosses the line and is seen in the cuttings with boulder clay and sand, having a total depth of 10 yards. It is also met on the shores of a tributary of the Maganatawan river. This material was used for ballast.

Seven miles east of Burks Falls the fine sand beach on the southern shore of Pickerel lake is capable of supplying thousands of tons of clean washed sand.

In Burks Falls, half-way between the station and the mill, there is a gravel pit 30 yards long and 15 yards deep, containing large boulders of gneiss, banded quartzite, etc., and some clay. In the centre of the town, there is a large gravel pit belonging to the municipality. The present excavation is 75 by 20 by 8 yards in size, and the pit supplies both sand and gravel. The stratification is oblique.

In the township of Ryerson there are two pits about nine miles west of Burk's Falls.

In the township of Armour the following pits were noticed:

1. Chas. Freer's pit.
2. A. Hego's pit at Barriedale, supplying gravel.
3. D. J. Van Meer's gravel pit (clean material sold at 25 cents a load).
4. John Hughes' pit.
5. G. T. railway gravel pit, on lot 14, Con. XIII. The present excavation is 300 by 30 by 15 yards in size. The gravel is of good quality for railway work.
6. Knight Bros.' gravel pit. This material is used for roadwork.

In the northeastern corner of Parry Sound district there are large areas of sand near Trout Creek station, between Powassan and Burks Falls. Near Powassan there is a sandpit 200 by 15 by 5 yards in size along the east side of the G. T. railway tracks. Outcrops of gravel are met in the cuttings of the railway between Powassan and Callander.

The area south of lake Nipissing is a plateau lying about 125 feet above the water level of the lake. It consists of rounded rocky hills, often showing glacial striae and at some places it is covered by residual or maraine deposits of unassorted sand and gravel. The southern shore of lake Nipissing itself is mostly a sand beach, the material being of various grades in different localities. The finest beach sand in some places has been driven two miles inland by the wind. There are also some scattered deposits of gravel along the shore of lake Nipissing.

Nipissing District

Going from North Bay along the Temiskaming and Northern Ontario railway sandy material is shown in a cut about 3.5 miles north. This appears to be derived from the weathering of the underlying rock.

Near Trout Mills (mileage 7.5) there is an old pit about 300 by 30 by 10 yards in size. The material was largely used for fills on the railway, as it was rather dusty for ballast. Very little was taken out in 1917.

At mile 25 is a pit 250 by 15 by 5 yards, extending in a N.E. and S.W. direction. Toward the S.W. end the thickness of the deposit is not so great as at the N.E. end.

The material is a clean gravel, while at the N.E. end it is a coarse sand well suited for building. In size the material ranges from sand to boulders one to two feet in diameter, and the rocks from which it is derived are granite, gneiss, conglomerate, diabase, quartzite, and other rocks, principally intrusive. The pit lies north of a small lake, and this deposit probably represents the shoreline of the lake when it was at a higher level. For the past two years the pit has not been worked.

Near Tomiko station is a large abandoned pit, about five yards deep, from which filling and ballast were obtained for the building of the railroad.

At Rabbit Creek, mileage 58.5, is a pit on the east side of the railway, about 500 by 100 by 10 yards, from which ballast of good quality has been secured. Boulders are not numerous. The bulk of the material consists of gravel ranging in size from ¼ inch to 3 inches in diameter, and the pit is worked intermittently by steam shovel. The upper portion of the deposit consists of sand. At the east end of the pit bed rock is encountered, and rock outcrops are shown to the north of the pit.

North of Doherty station and just south of Twin lake, is another large gravel pit from which ballast was obtained for a revision of the line near Doherty.

About one mile northeast of Cassidy station is a pit 800 by 25 by 7 yards in size. This is a coarse gravel, with numerous boulders ranging from six inches to one foot in diameter. The pebbles are predominantly granite and gneiss. Large reserves are still available.

Timiskaming District

Between Haileybury and New Liskeard the shore of lake Timiskaming and the adjoining slopes are covered with clay. Near the shore several masses of rocks of the Cobalt series outcrop in dome-like hills. Sometimes a little sand is found on the surface in a layer one to two feet in thickness overlying the clay, but these deposits are local. After stormy weather a certain quantity of sand and gravel is deposited on the lake shore. The fragments are angular and small. The predominant rock in the gravel is a light-coloured limestone of Silurian age containing numerous fossils.

Along the lake shore south of Haileybury toward North Cobalt the composition of the gravel changes and pre-Cambrian rocks are more prominent. There are large reserves of this surface material, and it has been used for building operations.

Around Martineau bay of L. Timiskaming is a deposit of sand well suited for building purposes. The sand extends along the slopes of the adjoining hill and can be seen on both sides of the old Mission road. Large quantities of clean sand are available, which could be transported by scows to points on the lake.

MAIN LINE, T. AND N. O. RAILWAY

Cobalt and Vicinity.—Near the North Cobalt school-house a small deposit of sand has been worked. This is mixed with gravel and is only about a foot in thickness.

The sand pit of the Chambers-Ferland mine near mile 104 is an excavation 80 by 40 by 5 yards. Most of the available material has been removed. It is principally light-coloured sand, which contains patches of gravel.

To the west of mile 104 on the T. & N. O. Ry a gravel pit parallels the railroad on the ridge near the cemetery. The size of the excavation is 75 by 10 by 3 yards. The gravel is varied in composition, consisting principally of rocks of the Cobalt series and granite. A little further west is another excavation about half as large containing a good amount of small gravel. This is screened for use in concrete work.

About 2½ to 3 miles west of West Cobalt the soil becomes more sandy and contains a large proportion of pebbles. Near the powder factory it is a gravel. Small pits have been opened along the road for road building.

In lot 10, Concessions IV and V, township of Coleman, is a pit about a mile long, 50 yards wide and 15 yards deep. The material is principally a mixture of sand and gravel, but at some places clay is visible in the walls. The pebbles rarely are more than one foot in diameter, but occasional boulders as much as 3 feet in diameter were seen. Basic igneous rocks are prominent, though granite and gneiss are abundant. Large reserves are still available.

Nellie Lake.—Nellie Lake station, township of Calvert, is in the midst of a sandy plain, which extends about 500 yards east and about 1,500 yards west. Since the fire of 1916 this plain has been covered with partially burned forest. Just east of the station is a small kettle lake, the level of which is about 60 feet lower than the station. The altitude of the station is about 1,000 feet, but about 500 yards east of this point and about 150 feet above the level of the plain there is a sand ridge consisting of a series of hills ranging from 300 to 500 yards in length, with a width of from 200 to 300 yards. This ridge is approximately parallel with the T. & N. O. Ry.

A pit has been opened on the west side of one of these sand hills and a railway siding has been extended to the pit. Both sand and gravel have been obtained, the finer grained material being near the surface. The gravel is quite variable in size, and contains boulders up to 18 inches in diameter. This pit is about 250 by 7 by 2 yards. Just to the east of this, along the same railway siding, a larger pit has been opened. The gravel is apparently reassorted glacial material, consisting of pebbles of granite, gneiss and quartz. A line of kettle lakes between the pits and the railway gives further confirmation of the glacial origin of these deposits.

Distinct bedding in the deposit was not observed, but the face of the workings is not fresh, and the falling of the upper portion has probably masked the true condition.

Cochrane.—About one mile north of Cochrane there are several kettle lakes, surrounding which are deposits of morainic origin. To the west of the pump-house there is a sand pit about 20 yards in diameter by 5 yards deep, which furnishes building sand.

A little further north, between two kettle lakes, is a gravel ridge in which is a pit known as the town pit. The gravel is cross-bedded and consists of small pebbles. The present excavation is about 75 by 25 by 7 yards, with a reserve of about equal dimensions.

About two miles southeast of Cochrane is a large gravel pit in a ridge to the east of a kettle lake. This pit is about 800 by 40 by 10 yards, and furnished ballast and filling for the T. & N. O. railway.

PORCUPINE BRANCH, T. AND N. O. RAILWAY

Timmins.—Sand and gravel has been taken from a pit south of the road from Timmins to Schumacher. The pit is about 12 feet deep and 15 yards in diameter. As a rule the pebbles are not more than four inches in diameter, and are composed of granite, gneiss, schists and basic igneous rocks. This material has been used for roads and building. Another pit on the same side of the road is about 75 by 25 by 7 yards, and has been practically exhausted. On the opposite side of the road is a pit near the railway which is more sandy, but furnishes material used for building.

Drinkwater pit.—On the north side of the railway is a pit 300 by 30 by 10 yards which has been abandoned.

Connaught.—At Connaught station a steam shovel was operating a gravel pit in 1917 and 1918, and 230 car loads were shipped.

Barber Bay.—Northwest of the railway there is a pit about 200 yards long by about 40 to 50 yards wide, with an average depth of 5 yards. Large boulders are not numerous, the average not exceeding four inches in diameter. The pebbles consist of gneiss, granite, schist, and greenstone. There is a large reserve yet available at this pit.

CANADIAN NATIONAL RAILWAY

Buskego.—About eight miles west of Cochrane a pit 600 by 100 by 15 yards furnished a sandy gravel which in some portions has been cemented by calcareous solutions. This was used for ballast on the Canadian National Railway, formerly called the National Transcontinental.

Drainage of some of the small lakes surrounding the pit could be effected easily and permit 20 feet additional depth to be worked by steam shovel.

Moonbeam.—A little west of Moonbeam, on the railway, near mile 57 (west of Cochrane), an old siding branches to the south to several ballast pits. The first of these is about a mile south of the track, and shows an excavation about 300 yards long by 15 yards wide and 10 feet deep. The upper portion of the deposit is sand, but the lower part is good, clean gravel suitable for concrete. The gravel is chiefly derived from Laurentian rocks, and the pebbles are usually small, though boulders as large as three feet in diameter are found.

About 1½ miles south of this first pit is another about 400 yards long by 50 yards wide and 10 yards deep. The character of the deposit is practically the same as in the first pit.

A third pit two miles south of the second one shows an excavation 300 yards by 20 yards by 5 yards in a ridge between two narrow lakes. The gravel is somewhat coarser than in the first two pits, and is suitable for ballast. One mile south of this pit is a fourth pit in a hill about a mile long by 400 yards wide and a maximum height of about 30 yards. The gravel is fairly coarse, with numerous pebbles from four to six inches in diameter, and boulders as large as six feet in diameter in places. The pebbles are principally derived from pre-Cambrian rocks, and consist of granite, gneiss, quartzite, and greenstone. There is a large reserve in this pit.

Harty.—About 400 yards south of Harty, mile 81, is a pit about 600 by 30 by 6 yards, which furnishes gravel for ballast. There is still a reserve.

Algoma District

CANADIAN NATIONAL RAILWAY

Mattice.—Near mileage 100.3, just east of the bridge over the Missinabi river, lot 27, con. IV, Eilber township, is an old pit from which gravel was obtained for ballast and concrete for the bridge piers. The excavation is about 80 by 40 by 5 yards, with possibly an equal reserve left. The pebbles consist of granite, gneiss, and limestone.

To the northeast of this pit, in lot 26, Con. IV, Eilber township, is a larger pit 400 by 50 by 5 yards, which furnished ballast. This deposit is practically exhausted, and the railway siding has been removed.

Hearst.—Four miles north of Hearst is a hill about 30 to 40 feet above the general level which is somewhat loamy in places. At a depth of three or four feet sand suitable for concrete, plastering and brick-work has been found. This hill extends for about a mile and a half in a N.E-S.W. direction. In some places gravel suitable for roads and concrete is encountered. The pebbles range from an inch or an inch and a half down to the size of a grain of wheat. The gravel is quite clean, particularly near the bottom of the pit. The hill is about 400 yards wide and about 15 yards high, and would probably furnish 10,000,000 cubic yards. Over some parts of the hill a deposit of moulding sand ranging from one to two feet in thickness is found.

ALGOMA CENTRAL AND HUDSON BAY RAILWAY

Hearst to Hawk Junction.—Between Hearst and Oba no sand or gravel deposits were observed. The first deposit of this kind was seen near Lake Oba. These deposits were used for ballast by the Algoma Central and Hudson Bay railway. Deposits of a similar character occur near a number of lakes in this region. Between Franz and Hawk Junction the country is more rocky, but several large silty gravel hills were seen along the railway.

Michipicoten River.—North of Michipicoten river there is a sandy beach with several terraces above. The sand in the terraces is not very clean, but large reserves are available for water transportation. The beach sand is clean and would probably furnish good building material.

Wawa Station.—One-half mile south of Wawa station is an old ballast pit which was used by the Algoma Central & Hudson Bay railway. The material is a sandy gravel.

Hawk Junction to Sault Ste. Marie.—Along the line of the Algoma Central and Hudson Bay railway from Hawk Junction to Sault Ste. Marie there are numerous terraces at different elevations which would furnish large quantities of sand and gravel. Material has been taken from some of these for ballast for the railway,

but with the exception of a few pits near Sault Ste. Marie none of them have been used for any other purpose. Until this region is more thickly settled, there is little prospect of these deposits being utilized.

Sudbury District

Sudbury.—On the south side of Elm Street West there is a large deposit of sand and gravel that has been used extensively for building purposes. All grades from fine sand to gravel with pebbles two inches in diameter are found. As a rule the several grades are very clean, and the gravel is suitable for concrete work.

The highest point of the deposit is 920 feet above sea level, and the thickness is about 25 feet. Outcrops of rock are shown in the bottom of the pit.

The material consists principally of fragments of quartz and basic rocks, probably of the Sudbury series. Oblique bedding is shown, and evidently the deposit is found under water. The sand on the surface has been subjected to the action of wind, so that some parts of the deposit now present a dune-like appearance.

CANADIAN PACIFIC RAILWAY

Cartier.—About one mile north of Cartier station and west of the railway tracks is a terrace about 20 feet higher than the tracks. A pit about 400 yards long has been worked here for railway ballast. At present the pit is not in use. The material appears to be chiefly sand. The region here is a sandy plain, with a number of rocky hills, and covered with numerous boulders of granite and similar rocks.

Larchwood to Levack.—Half a mile northwest of Larchwood the Canadian Pacific railway crosses the Vermilion river, which flows between banks of sand and clay. About two miles west of Larchwood, where the track turns to the west, the railway cuts through a ridge of sand about 50 yards wide and about 30 feet high. This sand is horizontally stratified. The ridge runs in a northwest direction more or less parallel with the railway for a third of a mile, and can be followed for more than a mile. In the railway cut the material is fine-grained sand, but near Phelan it develops into a large gravel deposit, which has been worked as a ballast pit. The present excavation is about one-half mile long, 100 yards wide, and about 15 yards deep. The gravel is quite clean and contains few pebbles more than six inches in diameter. The small pebbles are not much rounded, indicating that they had not been transported a great distance. The pebbles consist principally of granite, diabase, gabbro and sandstone, and the upper portion is as a rule sandy.

The north end of the pit is worked at present by steam shovel. Here alternating beds of sand and gravel of different grades showing oblique stratification are shown. The intermixture of these by the steam shovel gives a product not as clean as the gravel, near the centre of the pit, which is of excellent quality for concrete work. The material is used for filling and ballast. In 1917 the average production was from 2,000 to 3,000 yards per day for four months. This pit was first opened about 35 years ago, but was idle for many years. A large reserve, several hundred yards wide, remains.

Windy Lake.—About one mile south of Windy Lake station there is a large gravel pit which was used for ballast but is now abandoned. This pit is about 1,500 by 75 by 10 yards in size. It is located in a terrace to the north of Windy lake and on the west side of the railway. The reserve in this deposit is probably three times the amount taken out. Near the centre of the pit the gravel is very clean, and would be suitable for concrete work. Towards the ends of the pit the material is more loamy, but the upper part has fallen over the face so that the stratification is concealed and it is impossible to tell what proportion of clean sand or gravel is present.

END OF PART II

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Report of

ONTARIO BUREAU OF MINES, 1918

Vol. XXVII., Part III.

Section I

COBALT

ITS

OCCURRENCE, METALLURGY, USES AND ALLOYS

By

Charles W. Drury

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LIST OF DIAGRAMS

MAP—(*Insert*)

Introductory Note by Author

In preparing this review of the occurrence, metallurgy, uses, chemistry and alloys of cobalt the author has made an attempt to collect all published information concerning this metal, and has added some remarks of his own.

Owing to the growing importance of cobalt and its compounds, and also to the interest that is being taken in the metal because of the similarity of some of its properties to those of nickel, it was felt a compilation and summary of all scattered information should be made. Besides having the general information in accessible form, it is hoped that the various summaries and the list of references in the review, especially those in the section on alloys, will be of assistance to any investigators attempting to study the metallurgy or the alloys of the metal cobalt.

C. W. D.

Queen's University,
Kingston, Canada,
July 1st, 1918.

COBALT

ITS OCCURRENCE, METALLURGY, USES AND ALLOYS

By Charles W. Drury

CHAPTER I

COBALT MINERALS, THEIR COMPOSITION AND OCCURRENCES

Summary of Most Important Deposits of Cobalt

Of the present known deposits of cobalt ores there are only five that are either being worked or are suitable for working at present, viz., those of Cobalt, Ont., Missouri, New Caledonia, Belgian Congo, and Schneeberg, Germany.

Those of Cobalt are the largest, and the shipping ore and concentrate contains an average of 7 to 10 per cent. of cobalt, 5 per cent. of nickel, 25 per cent. of arsenic and 300 to 1,000 ounces of silver. The higher grade silver ores are associated with calcite in narrow veins. The cobalt and nickel minerals occur chiefly as arsenides.

The ores of southeastern Missouri, occurring in the vicinity of Fredericktown, are associated with an entirely different class of minerals, as may be seen from the following approximate composition of the ore: copper, 2 to 3 per cent.; lead, 1.5 to 2.5; cobalt, 0.5 to 0.7, and nickel, 0.7 to 0.9 per cent. Arsenic and silver are not found with the Missouri cobalt ores. The copper and lead occur chiefly as sulphides, and the cobalt and nickel are more closely associated with the copper than the lead minerals. Iron and zinc sulphides are also present.

In the New Caledonia deposits, the cobalt occurs chiefly in the oxide form, the ore averaging 3 to 4 per cent. cobalt oxide. Manganese, nickel and iron oxides occur with the cobalt.

The association of cobalt with copper in Belgian Congo is of importance. As mentioned again in the report, in 1913 8,064 tons of copper, containing from 2.8 to 3.25 per cent. cobalt, were exported to Germany to be refined electrolytically. As this tonnage could yield perhaps 150 tons of cobalt, it is important when the total world's production is not more than about 500 tons.

The cobalt ores of Schneeberg are associated with nickel and bismuth minerals, the bismuth being the most important. Few analyses have been published showing the content of the ore, but those given for development work show about 2 per cent. of cobalt and 1 per cent. of nickel, the percentage of bismuth being considerably more than of cobalt and nickel.

It is a most difficult task to estimate the tonnage of cobalt ores available or developed. There is no question that the Canadian deposits will be the greatest source of cobalt for some years. The ores of Missouri, although containing considerably less cobalt than those of the other countries, are extensive, and will be sufficient to supply practically all the demands in the United States, which are now about 150 tons annually. The Missouri ores are being treated at present by the Missouri Cobalt Company, which is the only producer of cobalt in the United States. The reason why the deposits of New Caledonia are not being operated is the low price of cobalt and the high cost of transportation. However, if the price of cobalt continues to advance, there is no doubt that they will be reopened.

Cobalt Minerals

Cobaltite, Cobalt Glance.

Isometric; pyritohedral. Commonly in cubes, or pyritohedrons, or combinations resembling common forms of pyrite. Also granular, massive to compact.

Cleavage; cubic, rather perfect. Fracture uneven. Brittle. H.=5.5. G.=6-6.3. Lustre metallic. Colour; when freshly broken, silver-white inclined to red, also steel-gray with a violet tinge, or grayish black when containing much iron. Streak grayish black.

Composition; sulpharsenide of cobalt, CoAsS or $CoS_2.CoAs_2$, sulphur 19.3, arsenic 45.2, cobalt 35.5.

Occurs at Tunaberg, Riddarhyttan, Vena, and Hakansbö, in Sweden; at the Ko and Bjelke mines of Nordmark; also at Skutterud in Norway. Other localities are Querbach in Silesia; Schladming, Styria; Siegen in Westphalia (from the Hamberg mine, the ferrocobaltite); Dobsina, Hungary; Val d'Annivier, Valais; Botallack mine, near St. Just, Cornwall; Daschkessan, near Elizabethpol, in the Caucasus; Khetri mines, Rajputana, India. The ore from the Khetri mines was sold to the Indian enamellers and jewellers under the name of sehta. Deposits also occur at Tambillos and at Huasco, Chile.

In the United States, it occurs with chalcopyrite and gold in the Quartzburg district, near Prairie City, Grant county, Oregon.

In Canada, at Cobalt, Ontario.

Smaltite, Gray Cobalt Ore.

Isometric; pyritohedral. Commonly massive; in reticulated and other imitative shapes.

Cleavage; o distinct; a in traces. Fracture granular and uneven. Brittle. H.=5.5-6. G.=6.4-6.6 Lustre metallic. Colour; tin-white, inclining when massive, to steel-gray, sometimes iridescent, or grayish from tarnish. Streak grayish black. Opaque.

Composition; essentially cobalt diarsenide. $CoAs_2$, arsenic 71.8, cobalt 28.2.

Occurs usually in veins, accompanying ores of cobalt and of silver and copper. Such associations are found at Freiberg, Annaberg, and particularly Schneeberg, in Saxony; at Joachimsthal in Bohemia, the reticulated varieties are frequently found embedded in calcite; also at Wheal Sparnon in Cornwall; at Tunaberg in Sweden; Allemont in Dauphiné; at the silver mines of Tres Puntas and Veta Blanca, Chile.

In the United States, it occurs in calcite gangue, associated with small quantities of erythrite and native silver, near Gothic, Gunnison county, Colorado.

In Canada, at Cobalt, Ontario.

Linnaeite, Siegenite, Cobalt Pyrites.

Isometric. Commonly in octahedrons. Also massive, granular to compact.

Cleavage; cubic, imperfect. Fracture; uneven to subconchoidal. Brittle. H.=5.5. G.=4.8-5. Lustre; metallic. Colour; pale steel-gray, tarnishing copper-red. Streak blackish gray.

Composition; $Co_3S_4=CoS.Co_2S_3$, sulphur 42.1, cobalt 57.9. The cobalt is replaced by nickel (siegenite) and to some extent by iron and copper in varying proportions.

Occurs in gneiss with chalcopyrite, at Bastnaes, near Riddarhyttan, and at Gladhammar, Sweden; at Müsen, near Siegen, in Prussia, with barite and siderite; at Siegen (siegenite), in octahedrons.

In the United States, it occurs with chalcopyrite, pyrrhotite, galena, and bornite in a number of mines of southeastern Missouri, especially in Madison county, at Mine la Motte and Fredericktown, and in St. Francois county; also at Lovelock's Station, Nevada; at Mineral Hill copper mines, Carroll county, Maryland, and at Finksburg, Maryland, associated with copper ores, sphalerite and pyrite, in chlorite schist.

Erythrite, Cobalt Bloom, Red Cobalt, Cobalt Ochre.

Monoclinic. Crystals prismatic and vertically striated. Also in globular and reniform shapes, having a drusy surface and a columnar structure; sometimes stellate. Also pulverulent and earthy, incrusting.

Cleavage; b highly perfect. Sectile. H.=1.5-2.5. G.=2.9. Lustre of b pearly, other faces adamantine to vitreous, also dull and earthy. Colour; crimson and peach-red, sometimes gray. Streak a little paler than the colour, the dry powder deep lavender-blue.

Composition; hydrous cobalt arsenate, $Co_3As_2O_8.8H_2O$. As_2O_5 38.4, CoO 37.5, water 24.1. The cobalt is sometimes replaced by nickel, iron, or calcium.

Occurs at Schneeberg in Saxony, in micaceous scales; in brilliant specimens, consisting of minute aggregated crystals, at Saalfeld in Thuringia; also at Riechelsdorf in Hesse; Modum in Norway; with bismuth at Bieber in Hesse; Andalusia, Spain; Piedmont, Italy. The earthy peach-blossom varieties have been observed at Allemont, in Dauphiné, France; at the Botallack mine, near St. Just, Cornwall; near Alston in Cumberland; and near Killarney in Ireland. A perfectly green variety occurs at Platten in Bohemia, and sometimes red and green tinges have been observed on the same crystal.

In the United States, erythrite occurs in the northeast part of Churchill county, Nevada; near Blackbird, Lemhi county, Idaho; at Josephine mine, Mariposa county, and at Kelsey mine, Los Angeles county, California; also at Lovelock mine, Humboldt county, Nevada.

In Canada, at Cobalt, Ontario.

Willyamite.

Cleavage: cubic. Fracture: uneven. Brittle. H.=5.5. G.=6.87. Lustre; metallic. Colour; between tin-white and steel-gray. Streak; grayish black.

Composition; $CoS_2.NiS_2.CoSb_2.NiSb_2$. A sulph-antimonide of cobalt and nickel.

Found at the Broken Hill mines, in Willyama township, New South Wales, associated with dyscrasite in a calcite and siderite gangue.

Skutterudite.

Isometric; pyritohedral. Also massive granular.

Composition; cobalt arsenide, $CoAs_3$.

Cleavage: a, distinct. Fracture uneven. Brittle. H.=6. G.=6.72-6.86. Lustre; metallic. Colour; between tin-white and pale lead-gray, sometimes iridescent.

Found at Skutterud, near Modum, Norway, in a hornblende gangue in gneiss with titanite and cobaltite, the crystals sometimes implanted on those of cobaltite.

Bismutosmaltite.

Composition; $Co(As.Bi)_3$. A skutterudite containing bismuth. Colour; tin-white. G.=6.92.

Occurs with other bismuth minerals at Zschorlau, near Schneeberg, Saxony.

Asbolite, Asbolan, Earthy Cobalt, Wad.

Composition; an impure mixture of manganese and other metallic oxides. Some varieties have been known to contain as much as 32 per cent. of cobalt oxide.

Occurs at Riechelsdorf in Hesse; in Westerwald district between Rhenish Prussia and Westphalia; at Saalfeld in Thuringia; at Nerchinsk in Siberia; at Alderley Edge in Cheshire; Asturias, Spain; and New Caledonia.

An earthy cobalt mineral occurs at Mine la Motte, Missouri, associated with copper, iron, nickel, lead and sulphur; also near Silver Bluff, South Carolina.

Roselite.

Triclinic.

Composition; $(Ca.Co.Mg)_3As_2O_8.2H_2O$. H.=3.5. G.=3.5-3.6. Occurs in small crystals; often in druses and spherical aggregates. Colour; light to dark rose-red.

Found at Schneeberg, Saxony, on quartz (1842); later obtained from the same region at the Daniel and Rappold mines; also reported from Schapbach, Baden.

Sphærocobaltite.

Rhombohedral. In small spherical masses, with crystalline surfaces, rarely in crystals. H.=4. G.=4.02-4.13. Lustre; vitreous. Colour; rose-red altering to velvet-black. Streak; peach-blossom red.

Composition; cobalt carbonate—$CoCO_3$.

Occurs sparingly with roselite at Schneeberg, Saxony.

Remingtonite.

A rose-coloured incrustation, soft and earthy. Streak; pale rose-coloured.

Composition; a hydrous cobalt carbonate.

Occurs as a coating on thin veins of serpentine, which traverse hornblende and epidote at a copper mine near Finksburg, Carroll county, Maryland.

Safflorite.

Orthorhombic. Similar to smaltite, essentially cobalt diarsenide, $CoAs_2$. Form near that of arsenopyrite. Usually massive, sometimes showing fibrous radiated structure. Lustre; metallic. Colour; tin-white, soon tarnishing to dark gray.

Occurs with smaltite and implanted upon it, at Schneeberg, Saxony. Also similarly associated at Bieber, near Hanau, in Hesse; at Wittichen in Baden; Tunaberg in Sweden.

Glaucodot.

In orthorhombic crystals. Also massive. Brittle. H.=5. G.=5.90-6.01. Lustre; metallic. Colour; grayish tin-white. Streak; black.

Composition; a sulpharsenide of cobalt and iron. (Co,Fe)AsS.

Occurs in chlorite slate with cobaltite in the province of Huasco, Chile; also at Hakansbö, Sweden.

Alloclasite.

Commonly in columnar to hemispherical aggregates. H.=4.5. G.=6.6. Colour; steel-gray. Streak; nearly black.

Composition; probably essentially Co(As,Bi)S, with cobalt in part replaced by iron; or a glaucodot containing bismuth.

Occurs at Orawitza, Hungary.

Bieberite.

Composition; hydrous cobalt sulphate; $CoSO_4.7H_2O$.

Occurs as rose-coloured stalactites in the old mines at Bieber, in Hesse; at Leogang, in Salzburg; at Tres Puntas, near Copiapo, Chile.

Cobaltomenite.

Probably cobalt selenite, $CoSeO_3.2H_2O$.

Occurs with chalcomenite (hydrous cupric selenite), at Cerro de Cacheuta, Argentina.

Jaipurite.

Composition; described as a simple cobalt sulphide, CoS, occurring massive. G.=5.45. Colour; steel-gray.

It is stated that this mineral was used by Indian jewellers.

Carrollite.

Isometric, rarely in octahedrons. Usually massive. H.=5.5. G.=4.85. Colour; light steel-gray, with a faint reddish hue.

Composition; a copper cobalt sulphide, $CuCo_2S_4=CuS.Co_2S_3$, cobalt 38.0, copper 20.5, sulphur 41.5.

Occurs at the Patapsco mine, near Finksburg, Carroll county, Maryland, and also at the Springfield mine, associated and mixed with chalcopyrite and chalcocite.

Sychnodymite.

Isometric, in small steel-gray octahedrons.

Composition; essentially $(Co,Cu)_4S_5$. Part of the cobalt may be replaced by nickel.

Occurs, associated with quartz, siderite, and tetrahedrite, at the Kohlenbach mine, southeast of Eiserfeld in the Siegen district, Prussia.

Pateraite.

An impure, massive mineral of black colour, supposed to be a molybdate of cobalt. Vogl discovered pateraite associated with uranium ores in the Elias mine, Joachimsthal, Bohemia.

Transvaalite.

An oxidation product of cobalt arsenide.

Occurs in black nodular masses forming veins in quartzite at a cobalt deposit. 30 miles north of Middleburg, Transvaal, South Africa. An analysis of a sample of transvaalite showed 1 oz. 12 dwt. of gold per ton.

Heterogenite; Heubachite; Winklerite.

These are hydrated oxidized cobalt minerals, containing nickel, copper, iron. or manganese.

Cobalt is also an occasional constituent of many other minerals, especially of pyrrhotite (sulphide of iron) and arsenopyrite (sulpharsenide of iron), and is usually present in nickel ores. Cobaltiferous varieties of arsenopyrite, known as danaite, are probably due to isomorphous intergrowths of glaucodot.

Metallic cobalt has been recorded as occurring in meteorites.

Summary of the World's Cobalt Deposits*

*A large part of the description of the world's cobalt deposits as given in this section is taken from the Nineteenth Annual Report of the Ontario Bureau of Mines, Part II, by Willet G. Miller.

Germany and Austria

Deposits of cobalt-silver ores resembling those found in the vicinity of Cobalt, Canada, are found in Germany and Austria. The two areas in these countries are those of Annaberg and Joachimsthal. Mining was begun in the latter about the end of the fifteenth century, while it is stated the deposits of the former were discovered in 1492.

The ores of those two regions are similar to those of Ontario, and contain compounds of cobalt, nickel, bismuth, and silver, with the ore of uranium, which has not been found in the Ontario deposits. The rocks belong to the older systems, but are different in composition from those of Cobalt.

At Joachimsthal, in Bohemia, there is a series of mica schist and limestone cut by dikes of basalt. The veins are said to be older in age than the basalt, and younger than the other rocks mentioned. The veins, which are narrow, contain quartz, hornstone, calcite, and dolomite as gangue material, and often show a brecciated structure.[1] The minerals of these veins are given in the following list:

1. Silver ores: native silver, argentite, polybasite, stephanite, tetrahedrite, proustite, pyrargyrite, and sternbergite.
2. Nickel ores: niccolite, chloanthite, and millerite.
3. Cobalt ores: smaltite as well as bismuth-bearing linnæite and asbolite.
4. Bismuth ores: native bismuth together with bismuthinite and bismuth ochre.
5. Arsenic ores: native arsenic and arsenical pyrites.
6. Uranium ore: uraninite or pitchblende.

[1] Beck, Erzlagerstätten, p. 290, 1903. Beyschlag, Krusch and Vogt, Die Lagerstätten der Nutzbaren Mineralien und Gesteine. Stelzner-Bergeat, Die Erzlagerstätten.

Associated with these are galena, zinc blende, pyrite, marcasite, and copper pyrites.

Among these ores those of cobalt and nickel are generally the older; those of silver the younger. The veins cut through dikes of quartz-porphyry, and are in turn cut by basalt and later dikes.

Of similar composition to those of Joachimsthal are the veins of Annaberg in Saxony. In this neighbourhood the rock is gray gneiss. There are two groups of veins, but the younger, carrying the silver-cobalt ores, are the more important of the ore bodies. The gangue material is chiefly barite, fluorspar, quartz, and breunnerite, with various cobalt, nickel, and bismuth ores, viz., chloanthite, smaltite, red and white nickel pyrites, annabergite, native bismuth, and rarely bismuthinite. Of the silver ores, pyrargyrite, proustite, argentite, native silver, and silver chloride are found. The subordinate gangue minerals are hornstone, chalcedony, amethyst, calcite, aragonite, kaolin, and gypsum; while among the ores are copper pyrites, galena, zinc blende, pyrite, marcasite, tetrahedrite, siderite, uraninite, uranochalcite, uranochre, gummite, and native arsenic. The fact that a large amount of silver chloride was mined at one time, is interesting.

From a large number of observations, the following is given as the relative ages of the various minerals of the Annaberg veins:

V. Decomposition products: annabergite and cobalt bloom.
IV. Silver ores and native arsenic.
III. Calcite and uraninite.
II. Breunnerite and cobalt-nickel-bismuth ores.
I. Barite, fluorspar, and quartz.

The silver-cobalt veins cut the older tin and lead veins of the district as well as the dikes of microgranite and lamprophyre. The latter, especially, are often cut by the silver-cobalt veins. These are cut by basalt, which occurs not only in true dikes, but also in boss-like forms.

Somewhat similar silver-cobalt ores are found in certain veins at Schneeberg, but they are not so strikingly like those of Joachimsthal and Annaberg. A like association of ores is found at Wittichen, where the veins occur in granite.

According to Von Cotta, the rocks of the Joachimsthal district consist of mica schist, together with more or less hornblende schist and crystalline limestone, the whole being cut by numerous dikes of quartz-porphyry and basalt. There are also two large granite masses which rise out of the mica schist. There are lodes of tin, silver, and iron compounds. Tin is found only in the granite region. Silver lodes are divided into four groups fairly distinct from one another. One set contains about 17, while another has 21 lodes. There are also others which do not come to the surface. Von Cotta also states that both classes of lodes intersect the mica schist, with all its subordinate strata, quartz-porphyry, and often even the dikes of basalt and wacké;[1] and that there seem to be cases where dikes of the basalt and wacké have intersected lodes or have penetrated their fissures. From this it may be deduced that the silver lodes were almost contemporaneous with the formation of the basalt, in that their fissures, in part follow the basalt dikes and in part are intersected by the basalt. At all events they stand in a certain genetic connection

[1] Wacké is an old term for a soft, earthy variety of trap rock.

to the porphyry, which here is evidently of much greater age than the basalt. The subject is still somewhat obscure. The silver lodes have not yet been found in the granite. Other writers do not agree with Von Cotta, as they appear to be of opinion that the basalt is younger than the veins.

The following notes are taken from Phillips' "Ore Deposits," p. 436, 1896.

The mountains known as Erzgebirge lie on the boundary between Saxony and Bohemia. Joachimsthal lies on the Bohemian side, and is therefore an Austrian town, while Annaberg is in Saxony.

The country rock in the neighborhood of Joachimsthal is for the most part mica sohist enclosed between masses of granite. In the eastern part of the mine there are some masses of included limestone, but in the western part, where the veins are not infrequently associated with dikes of porphyry, the gangue is almost quartzose. There are seventeen veins striking north and south, and seventeen others of which the direction is east and west. It has been constantly observed that the former exhibit a tendency to become enriched where they pass through the porphyry or included limestone, while the latter is not similarly affected when they come in contact with these rocks. The ores mined contained silver, cobalt, nickel, bismuth, and uranium. The uranium ores of Joachimsthal became valuable a few years ago, when it was found that uraninite was the chief commercial source of radium.

In 1864, when one shaft had reached a depth of 1,440 feet, a heavy outburst of water, at a temperature of 25°C. and evolving sulphuretted hydrogen, took place, and greatly interfered with underground operations. It was two years before this water could be successfully tubbed off and mining continued.

Cobalt minerals associated with granite are found in several other localities in the Erzgebirge, as well as at Wittichen and at Wolfach, in the Black Forest, where the veins occur in granite.

In Thuringia fault fissures in the Kupferschiefer and Zechstein are filled with barite, calcite and fragments of the country rock, together with smaltite, asbolite, and erythrite. They have been worked especially at Schweina, near Liebenstein.

The palæopicrite of Dillenburg (Nassau) contains cobalt, together with nickel, copper, and bismuth. At Querbach and Giehren, in the Riesengebirge, the mica schist near the contact with gneiss is impregnated with cobaltite, chalcopyrite, pyrite, pyrrhotite, arsenopyrite, blende, galena, magnetite, and cassiterite.

In the Fichtelgebirge, ores of cobalt and nickel are associated with siderite, bismuth, and barite. Siderite and copper ores are found with them in the Siegen district, Prussia.

In Alsace veins of smaltite, chloanthite and native silver in a calcite gangue were formerly worked at Sainte-Marie-aux-Mines.

Messrs. Schmidt and Verloop [1] have described the cobalt and nickel deposits of Schladming, Styria. The predominating ores are given as: niccolite, chloanthite, gersdorffite, and smaltite. Native bismuth and arsenic, arsenical pyrites and löllingite are also found.

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[1] **Schmidt and Verloop, Notiz über die Laerstätte von Kobalt und Nickelerzen bei Schladming in Steiermark: Zeitschr. prakt. Geologie, Vol. XVII, 1910, pp. 271-275.**

During the period from 1877 to 1880 there were obtained 29.3 tons of ore, containing 4,497 ounces of silver, 198 pounds of bismuth, 878 pounds of uranic oxide, 1.5 tons of arsenic, and 314 pounds of cobalt-nickel with a little lead, representing a total value of £1,687.

About this time it became evident that the uranic oxide was the most valuable product of these mines, and workings were especially directed to develop the minerals yielding it.

The Schneeberg mines during the year 1881 produced 158 tons of nickel and cobalt ores, valued at £5,902; 1,315 tons of silver ore, and 59 tons of bismuth ore, worth £3,292 and £16,933 respectively.

The production of cobalt ores in Prussia and Bavaria is given below.

PRODUCTION OF COBALT ORES IN PRUSSIA.[1]

Year	Cobalt Ore		Year	Cobalt Ore	
	Metric tons	Value		Metric tons	Value
		$			$
1852	233	16,376	1880	48	2,974
1853	12	5,652	1881	33	2,052
1854	14	6,676	1882	66	3,311
1855	10	4,534	1883	98	4,869
1856	6	3,882	1884	67	2,030
1857	3	1,761	1885	59	1,326
1858	1	767	1886	19	808
1859	....	....	1887	11	343
1860	0.3	17	1888	33	992
1861	1	72	1889	503	2,739
1862	1	75	1890	651	10,739
1863	1	291	1891	576	9,209
1864	143	1,470	1892	534	14,550
1865	0.2	37	1893	203	8,491
1866	....	....	1894	203	5,741
1867	23	12,313	1895	120	6,298
1868	25	8,371	1896	181	9,868
1869	27	6,764	1897	121	6,256
1870	16	3,762	1898	34	1,700
1871	18	4,228	1899	17	850
1872	219	14,547	1900	4	160
1873	286	13,820	1901	36	2,168
1874	254	35,757	1902	76	....
1875	200	19,789	1903	65	....
1876	158	19,076	1904	41	....
1877	70	5,233	1905	22	....
1878	46	2,955	1906	7	....
1879	49	3,074			

Cobalt products were made in Prussia continuously from 1852 to 1911. No cobalt ore was produced in Prussia after 1906 and very little since 1897, so that most of the ore treated must have been imported.

In 1884 and 1885 only was there any production of cobalt ores in Bavaria. During these years there were produced 160 tons and 349 tons of ore, valued at $600 and $1,050 respectively.

[1] Most of the figures in this and the following tables were taken from the Mineral Industry.

The production of cobalt ore in Saxony has not been published separately, but is given with bismuth and nickel ores. From 1878 to 1901 there was produced 25,350 tons of cobalt, bismuth, and nickel ores.

In 1904, one cobalt-silver mine in the Schneeberg district had a production valued at $132,147. The values were in silver, cobalt, nickel, bismuth, arsenic, uranium, samples, etc. These ores were treated at the "blue colour works," at Schneeberg. Both the government and private companies were interested in the industry. For a detailed description of the cobalt industry in Saxony, the reader is referred to "The Early History of the Cobalt Industry in Saxony," by Mickle. Report of Bureau of Mines, Ontario, Vol. XIX, 1913, pt. ii., pp. 234-251.

PRODUCTION OF COBALT ORES IN AUSTRIA.

Year	Nickel and Cobalt Ore		Year	Nickel and Cobalt Products	
	Metric tons	Value		Metric tons	Value
		$			$
1856	136	18,806	1856		
1857	387	5,508	1857		
1858	342	3,050	1858		
1859	371		1859	11	
1860	281		1860	5	
1861			1861		
1869 (*a*)	166	662	1869 (*a*)		
1870	50	108	1870		
1871			1871		
1872			1872		
1873	452	12,244	1873	23	20,150
1874	156	12,546	1874	37	22,460
1875	112	9,864	1875	22	18,892
1876	97	8,340	1876	22	13,734
1877	105	4,790	1877	14	7,896
1878	76	2,242	1878	6	3,502
1879	27	718	1879	5	1,280
1880	16	440	1880	4	1,142
1881	40	200	1881		
1882	15	210	1882	19	1,336
1883	4	158	1883		
1884	5	340	1884		
1885	137	1,546	1885		
1886	37	154	1886		
1887			1887		
1888			1888		
1889			1889		
1890	0.4	126	1890		
1891			1891	1.5	180
1892	0.3		1892	0.15	78
1893			1893	0.12	64
1894	0.5		1894	0.1	62
			1895		
			1896		
			1897	37.6	10,022
			1898	58.8	10,800
			1899	38.1	17,868
			1900	31.2	13,668
			1901	20.5	1,198

(*a*) From 1861 to 1869 inclusive, no record is given of any production of nickel and cobalt ore or products in Austria.

Deposits of the Chalanches, France

Silver, cobalt, and nickel ores somewhat similar to those of Germany occur in a network of narrow veins in crystalline schist at the Chalanches, in the Dauphiné, France. These deposits were discovered in 1761, and have been described by T. A. Rickard.[1]

The following notes are from Mr. Rickard's paper:

During the earliest period of mining at the Chalanches, some bodies of rich silver, nickel, and cobalt ore were found near the surface. It is said that two shots produced sufficient silver to pay for the two buildings known as the pavilions of Allemont, with their various ornamentations, including the fleur-de-lis which still adorn the roof. As 200 to 300 kilos of silver would at that time be worth from $10,000 to $15,000 this statement does not seem incredible.

It is remarkable that although the silver is always associated in the lodes with rich nickel and cobalt ores, often with bunches of stibnite, and more rarely and erratically with gold, the government engineers took no notice of any metal other than silver. The speiss[2] containing nickel and cobalt was rejected with the slags, and was used to fill the swamps or form road beds, which, in later times, were furrowed and turned over to recover their valuable contents.

The possibility of utilizing three metals instead of one seems to have dawned upon the engineers quite as a discovery; and this fact stimulated the repeated spasmodic attempts to rehabilitate the old mine. The arsenides of nickel and cobalt were sold in England and Germany. A German chemist was employed at Allemont to manufacture cobalt pigments for the arts, but was not successful, and the attempt was abandoned.

In 1891 gold was first recognized. However, its importance proved greater from a scientific than from a commercial point of view. The old mine-workings, aggregating 20 kilometres in length, showed that a great deal of unsuccessful exploration had been carried out.

The geological formation is simple. A network of veins traverses crystalline schists of variable character. The country rock forms a part of the great crystalline formation usually referred to as the Archaic schists of the Alps, though in point of fact they probably include rocks from the Archaic to the Carboniferous. Lithologically, certain sections suggest the Huronian and Laurentian. These schists lie immediately upon the granite; they are extremely variable in character, so that at different places they can be described as gneissoid, granitoid, talcose, micaceous, graphitic, or amphibolic. There are also blocks of rock containing epidote.

The maps of the mine exhibit a wonderful network of galleries spreading like a cobweb over an area of about 600 by 300 metres. It is computed that the workings aggregate in length not less than twelve miles, an extent in remarkable contrast to the relatively small quantity of ore produced.

It has been thought by several observers that the lodes were more numerous near the surface than in the interior of the mine. This is due to the fact that any single fissure, in approaching the surface, spreads itself out into a number of subordinate fractures. It has also appeared that the lodes gained in regularity as they penetrated the mountain. Caillaux, therefore, adds that this fact seems to indicate the probable occurrence in depth of only a small number of lodes, but that those surviving will have a regularity of structure greater than those which have been hitherto exploited. The veins vary in width from a knife-blade to 80 centimetres (31.5 inches); their usual thickness lies between 3 to 30 centimetres (0.1 to 1 foot).

Examination of the old workings proves clearly that farther from the surface the country rock gets harder, the vein matter loses its soft character, and the veins become fewer in number, more regular, narrower, and less ore-bearing. Approaching the surface, on the contrary, the schists are fractured in a multiplicity of directions, the veins become larger, their filling is generally earthy, and they throw off branches, at the intersections of which the ore bodies are found. In general, mineralization becomes more pronounced near the surface; this being due, not merely to the oxidation of the sulphides, but to an actual relative increase of 'orey' matter.

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[1] Rickard, The Mines of the Chalanches, France. Am. Inst. Min. Eng. Trans., Vol. XXIV, 1894, pp. 689-705.

[2] Speiss is a product formed in smelting which contains most of the metals in the form of arsenides.

The observations led to the conclusion that the richest part of the mine was that which was within the influence of oxidation, and that both chemical agencies and structural conditions favoured an enrichment of ore near the surface. This statement is particularly applicable to the silver contents. It also holds true of the gold, but it is less accurate with respect to the nickel and cobalt. The richness in silver of the oxidized ores suggests secondary precipitation. This is confirmed by the fact that the silver appears to be thrown down upon the nickel and cobalt arsenides and often envelops them in such a way as to impart the rudiments of a nodular structure. The hard, undecomposed arsenides contain small amounts of silver. The gold, occasionally present, is associated with soft, maroon-coloured, earthy iron-bearing vein matter. The nickel and cobalt minerals appear to be primary, and are more persistent than those of silver and gold.

If we accept the current theory that the nickel and cobalt came from the leaching of magnesium silicates (and facts are numerous pointing that way), then we must conclude that the origin of the nickel and cobalt ores of the Chalanches was not the immediately adjacent rocks, but ones similar, which underlie them at a greater depth. The silver and gold, it may be suggested, were precipitated from other solutions, and at a period other than that which saw the deposition of the nickel and cobalt. The precious metals were probably derived from a deeper-seated source, and may have been leached from the granite which underlies the schists and is penetrated by the basic eruptives. In both cases the various metals must have come from a depth where leaching action was powerful, and from which ascending currents brought the metallic constituents, the subsequent precipitation of which produced valuable ore-deposits.

Quartzose veins containing ferriferous smaltite were prospected in 1784 at Juzet, near Nance, Montauban-de-Luchon, Haute-Garonne. The ores produced together with those from Gistain on the Spanish side of the Pyrenees, were treated at Saint-Marnet.

Norway

The following description of the cobalt deposits of Norway is given by Phillips:[1]

The cobaltiferous fahlbands of the districts around Skutterud and Snarum occur in crystalline rocks varying in character between gneiss and mica schist; however, from the presence of hornblende, they sometimes pass into hornblende schists. These schists, of which the strike is north and south, and which have an almost perpendicular dip, contain fahlbands very similar in character to those of Kongsberg. They differ from those of that locality, however, inasmuch as while here the fahlbands are often impregnated with ore, those of Kongsberg, although to some extent containing disseminated sulphides, are only of importance as being zones of enrichment for ores which occur in veins. The ore zones usually follow the strike and dip of the surrounding rocks, and vary in width from 15 to 30 feet. The distribution of the ores is by no means equal. The predominant rock of the fahlbands is a quartzose, granular mica-schist, which gradually passes into quartzite, ordinary mica-schist, or gneiss. The ores were cobalt glance, arsenical and iron pyrites, molybdenite, and galena. It is remarkable that in these mines nickel ores do not accompany the ores of cobalt in any appreciable quantity. The principal fahlband is known to extend for a distance of about six miles, and is bounded on the east by a mass of diorite which protrudes into the fahlband, while extending from the diorite are small dikes or branches traversing it in a zigzag course. It is also intersected by dikes of coarse-grained granite which do not contain any ore, but which penetrate the diorite.

The Skutterud mine in 1879 produced 7,700 tons of cobalt ore, which yielded 108 tons of cobalt schlich,[2] containing from 10 to 11 per cent. of cobalt, and worth about £11,000. These deposits, which at one time were among the world's chief producers of cobalt, are of too low grade to be worked now.

Silver veins were discovered at Kongsberg in 1623. These veins resemble those of Cobalt in width, in that the numerous veins or stringers occur in small areas, and in the gangue mineral which is essentially calcite. However, nickel and cobalt minerals are not characteristic of the Norwegian deposits.

[1] Phillips, Ore Deposits, 1884, p. 390.
[2] Schlich is a term given to washed cobalt ore.

PRODUCTION OF COBALT ORES IN NORWAY.

Year	Cobalt Ore tons	Cobalt Ore value	Year	Cobalt Ore tons	Cobalt Ore value
		$			$
1866	85	20,600	1884	90	12,922
1867	30	7,500	1885	101	13,702
1868	5	4,368	1886	123	11,960
1869	30	14,456	1887	57	4,160
1870	10	4,056	1888	84	8,060
1871	25	13,520	1889	152	14,300
1872	65	35,152	1890	213	19,500
1873	75	40,560	1891	187	13,000
1874	65	35,100	1892	123	8,580
1875	60	32,500	1893	123	12,150
1876	95	49,400	1894	89	8,100
1877	105	52,000	1895	45	4,050
1878	105	52,000	1896	29	2,700
1879	108	52,000	1897	24	2,700
1880	87	45,500	1898	21	2,160
1881	80	41,600	1899	....	....
1882	99	52,000	1900	....	....
1883	84	14,326			

Most of the cobalt ore mined in Norway was exported.

In 1896 the cobalt works at Modum operated on a limited scale, employing 36 men.

Sweden

At Tunaberg, cobalt ore occurs in a bed of granular limestone in gray gneiss. The limestone contains, principally, hornblende, mica, and serpentine; also lead, silver, copper and cobalt minerals, copper pyrites and cobalt glance being the most frequent.

Other localities are Vena, near Askersund, on Lake Wetter, and at Gladhammar, south of Westerwik.

The following table shows the extent of the working of the cobalt deposits in Sweden.

PRODUCTION OF COBALT ORES IN SWEDEN.

Year	Cobalt Ore Metric tons	Year	Cobalt Ore Metric tons
1870	58	1882	516
1871	....	1883	177
1872	41	1884	56
1873	17	1885	137
1874	41	1886	164
1875	74	1887	231
1876	101	1888	143
1877	153	1889	266
1878	726	1890	145
1879	223	1891	244
1880	331	1892	53
1881	556	1893	101

In the years 1887, 1888 and 1889 there were also produced 376, 258, and 177 kilos of concentrated ore.

In 1888, 1889, 1890, 1891, 1892, and 1893, there were produced 7,270, 14,151, 15,414, 13,772, 15,703, and 7,255 pounds of cobalt oxide respectively.

Italy

Cobalt and nickel ores occur with quartz, calcite, and ores of copper in Piedmont.

Switzerland

Cobalt and nickel ores occur in Valais, and at Ayer in the Val d'Annivier and at Kaltenberg in Turktmanntal.

New Caledonia

Until the discovery of the cobalt deposits, at Cobalt, Ont., Canada, in 1903, about six countries were supplying the world with cobalt ores, New Caledonia producing probably 85 or 90 per cent.

When the ore from Ontario was put on the market, the prices fell materially in New Caledonia, and cobalt mining has now practically ceased in that country. It seems strange that Ontario should be the only serious competitor which this French colony, in the Southern Pacific, has in both nickel and cobalt.

The cobalt deposits of New Caledonia occur under conditions similar to those of nickel, and the two metals are frequently associated in economic quantities. New Caledonia is a non-glaciated country. The rock peridotite underlies a considerable part of the surface. This rock weathers readily, and so, over a large part of the surface, the alteration product, serpentine, occurs. The surface of the serpentine is more or less broken down, forming comparatively loose or slightly coherent deposits. It is in association with these that the cobalt is found, as asbolite, earthy cobalt, or cobaltiferous wad. Asbolite is a mixture of oxides of cobalt, manganese, and other metals and can hardly be called a distinct mineral. It has been proved that the cobalt, nickel, and other metals found in this decomposed rock were originally constituents of the peridotite.

The peridotites are believed by some writers to be post-Cretaceous in age, and are said to be in the form of a surface flow covering the uneven or eroded surface of the underlying Cretaceous strata. These rocks which are high in magnesia and low in iron, constitute the great serpentine formation of New Caledonia. They are more or less charged, when fresh, with crystals of ferro-magnesian pyroxene. The unaltered rock belongs, therefore, in Rosenbusch's classification, to harzburgite. Dunite, a variety of peridotite of which the main constituent is olivine, is found with chrome iron ore. The peridotites usually show traces of advanced alteration, which has resulted in more or less transformation of olivine to serpentine, and in the development of talc from pyroxene. At times the alteration is sufficiently advanced to produce perfect crystals of antigorite, with some films of talc.

Since these rocks always contain a little manganese, nickel, and cobalt, it would appear that these metals occur in the olivine as well as in the enstatite. Grains of chrome ore are abundant in all samples. The rocks are often traversed by less basic dikes of the character of gabbro. Diorite sometimes outcrops in the middle of the serpentine exposures.

In one deposit,[1] it is said that the decomposed material occupies a profound depression in the serpentine. This basin is filled by a red, clay-like deposit which has a depth of about 52 metres in the centre and 10 or 12 metres around the border. The richest ores appear to occur near the centre of the basin and near the contact of the serpentine.

It will be seen that all the cobalt deposits are irregular in form, and hence it is difficult to estimate their value.

Much of the mineral mined contains only two or three per cent. of oxide of cobalt and after washing probably 4.5 per cent. Cobalt ores from New Caledonia were purchased (1904) on a basis of 4 per cent. CoO, for which ore 330 francs[2] ($66.00) per ton was paid. In purchasing ores containing cobalt in excess of 4 per cent. CoO, a premium, which varied with the grade of ore, was allowed. The grades were divided as follows: those containing between 4 and 5 per cent. cobalt oxide. 5 and 6 per cent., 7 and 8 per cent., and above 8 per cent. Premiums of 0.8, 0.9, 1.0, and 1.5 francs for the different grades respectively were allowed for each 0.1 per cent. above the minimum per cent. of each grade. On this basis mineral carrying 8 per cent. would be worth 750 fr. ($150) a ton.

The prices paid for cobalt ore in New Caledonia in 1908 were about as follows: for 4.5 per cent. ore, $23 a ton; for 5 per cent. ore, $27 to $28 and 90 cents for each 0.1 per cent. above. At these prices, only rich, well-situated, and developed mines could be worked. An 8 per cent. New Caledonia ore at the price quoted would bring $54 a metric ton.

Ouvrard[3] reports the price of cobalt ore from New Caledonia and Chile as $35.00 per ton, c.i.f. European ports, for ore containing 4 per cent. cobalt; with a premium or penalty of $1.20 for each 0.1 per cent. cobalt above or below 4 per cent.

Previous to 1910 the Anglo-French Nickel Company of Swansea, Wales, bought some ore at Cobalt for the cobalt content alone, and paid 30 cents a pound for the metallic cobalt in an 8 per cent. ore. This is about $53 per ton for such ore.

The following analysis shows the composition of the New Caledonia ores: MnO_2 18, CoO 3, NiO 1.25, Fe_2O_3 30, Al_2O_3 5, CaO and MgO 2, silica 8, and loss on ignition 32 per cent.

In the following table the amount of cobalt ore exported from New Caledonia between 1893 and 1909 is given.

[1] Glasser, Report to the Minister of the Colonies on the Mineral Wealth of New Caledonia, 1904.

[2] A franc is worth about 20 cents.

[3] Ouvrard, Industries du Chrome, du Manganese, du Nickel, et du Cobalt, p. 253, Doin and Sons, Paris, 1910.

EXPORTATION OF COBALT ORE FROM NEW CALEDONIA.

Year	Cobalt Ore Metric tons	Year	Cobalt Ore Metric tons
1893	(a) 520	1903	8,292
1894	(a) 4,156	1904	8,964
1895	5,302	1905	7,919
1896	4,823	1906	2,487
1897	4,757	1907	3,943
1898	2,373	1908	3,405
1899	3,294	1909	979
1900	2,438	1910	.....
1901	3,123	1911	.....
1902	(b)	1914	(c) 920

(a) In 1893 and 1894, 169 and 7 tons, respectively, of matte were exported.
(b) Not reported.
(c) During 1914, New Caledonia exported 920 tons of ore and 25 tons of matte; Mineral Industry, Vol. 23, 1914, p. 548.

New South Wales

New South Wales was the second largest producer of cobalt ore before the discovery of the deposits at Cobalt, Ontario. The deposits, which are situated near Port Macquarie, are similar to those of New Caledonia.

During 1898, 1899, and 1900, 119, 193, and 145 tons of cobalt ore, valued at $2,800, $4,595, and $7,950 respectively were shipped.

In 1903 the quantity of cobalt ore exported from the deposits near Port Macquarie amounted to 153 tons, valued at $7,850. Since 1903, there have not been any shipments of cobalt ore made from New South Wales.

South Australia

Cobalt ore, containing smaltite and other minerals, occurs at Bimbowrie, near Olary, on the Broken Hill line, but little work has been done on the deposit.

Africa

While, as we have seen, silver has been worked in association with cobalt, the latter metal has been seldom found in association with gold in important quantities. However, one such occurrence is in the Middleburg district in northern Transvaal. In the vein in this district, the gangue material is kaolin, with which is mixed gold-bearing quartz. In the quartz are small nest-like aggregations of smaltite and copper ores, and at times molybdenite, also the secondary minerals cobalt bloom, limonite and skorodite.

A small amount of ore was produced in 1890 and also in 1895. During 1895 a quantity of ore analyzing 7 to 10 per cent. was reported to have been exposed. A brief account[1] of one of the cobalt deposits states:

[1] Geology of the Neighborhood of Middleburg, Transvaal Mines Dept., Pretoria, 1907.

Cobalt, in the form of smaltite and erythrite, is found at Balmoral, and also just beyond the northern boundary of the map in the valley of the Kruis river. At Balmoral the cobalt is associated with feldspar and actinolite, together with secondary quartz and calcite, in veins most probably of igneous origin, which traverse a series of highly altered sedimentary rocks of shaly character in the neighbourhood of the junction of the Waterberg and Transvaal systems.

Three additional references to cobalt deposits of the Transvaal are given below.

Beck, Note on Cobalt Lodes of the Transvaal: Trans. Geol. Soc., South Africa, vol. 10, 1907, p. 10.

Mellor, Note on the Field Relations of the Transvaal Cobalt Lodes: Trans. Geol. Soc., South Africa, vol. 10, 1907, p. 36.

McGhie and Clark, Transvaalite—A new Cobalt Mineral from the Transvaal: Jour. Soc. Chem. Ind., vol. 9, 1890, p. 587.

The crude copper produced by the Union Minière du Haut Katanga, Belgian Congo, of which 8,064 tons were produced and shipped to Germany in 1913, contained from 2.8-3.25 per cent. of cobalt. This formed a by-product easily saved in electrolytic refining and has been one of the chief sources of German cobalt in recent years.[1]

Cobalt and nickel oxides in small quantities (less than one per cent.) associated with chromite ores are found in Sekukuneland and in the neighbourhood of Selukiva (Rhodesia).

India

Cobalt ores[2] in small quantities were found in some of the mines of Rajputana, and were used for colouring glass bangles. Ores of this metal also occur in Tenasserim. Both cobalt and nickel are present in small quantities in the pyrrhotite from the Khetri mines, and traces of nickel sometimes occur in iron ores from Bhangarh.

Linnæite has recently been identified among some copper ores from Sikkim.

United States

Although there are no extensive deposits of cobalt in the United States, reports show that small quantities of cobalt oxide have been produced annually since 1869. Most of this was recovered in the refining of the copper-nickel ores of Sudbury, but at present practically all the cobalt is slagged in the converter, so that very little reaches the refinery. There has also been a small amount of cobalt oxide recovered from the lead-copper ores of Missouri, but with the exception of the years 1903 and 1908, the amount obtained has been small. In the years mentioned 120,000 and 100,000 pounds of oxide respectively were produced. Since the discovery of the cobalt deposits at Cobalt, Canada, cobalt ores have been shipped to the United States for treatment. Also the unrefined cobalt and nickel oxides produced at the smelter of the Canadian Copper Company[3] between 1905 and 1913, were shipped to the

[1] Min. Sci. Press. Vol. CVIII, 1914, p. 322; Mineral Resources of United States, U.S. Geol. Sur., Part I, 1913, p. 339.

[2] Phillips, Ore Deposits, 1884, p. 436.

[3] The production of the Canadian Copper Co. is given under the Metallurgy of Cobalt.

United States to be separated and purified. Previous to 1900, the Mine la Motte Company shipped ores to Swansea, but about this time a plant was erected at the mine to recover the cobalt oxide. This plant produced 120,000 pounds in 1903, but was closed shortly afterwards. In 1906 the North American Lead Company erected a refinery at Fredericktown, Missouri, to recover cobalt oxide from Missouri ores. This plant was operated during 1907, 1908, and 1909, but was closed in 1910. The reconstruction of this refinery was commenced in 1916 by the Missouri Cobalt Company, and during 1918 a quantity of cobalt oxide was produced. The Missouri Cobalt Company has erected a mill with a daily capacity of 300 tons.

In 1903 cobalt and nickel ore associated with fluorspar was said to have been discovered near Marion, Kentucky.

In 1905 one or two small shipments of cobalt ore from deposits in Grant county, Oregon, were made to France. These deposits are described as occupying fissures in a dark-greenish, partly altered, diabase-porphyry. The ore bodies appear to be more or less lenticular in shape, and vary from a few inches to several feet in width. The principal minerals are chalcopyrite, smaltite, arsenopyrite, pyrite, pyrrhotite, malachite, and bornite with a quartz and calcite gangue. The chief metals present were gold, cobalt, and copper. From a sample of the ore carrying smaltite and chalcopyrite the former mineral was found to have the composition given below, No. 1. This smaltite has a rather unusual appearance, resembling somewhat acicular or fine columnar stibnite. In composition it is close to that from Gunnison county, Colorado, an analysis of which is given by Dana, No. 2 below. The Standard Consolidated Mines Company, Oregon, worked during 1905 a few veins of cobalt ore carrying gold and silver. An analysis of a picked specimen of the ore follows, No. 3.

——	No. 1 [1]	No. 2	No. 3 [2]
Cobalt	14.88	11.59	9.91
Nickel	1.12	trace	0.57
Arsenic	64.06	63.82	42.66
Sulphur	0.57	1.55	....
Iron	11.14	15.99	14.93
Insoluble	2.22	....	....
Calcium carbonate	6.34	....	6.8
Silver	....	....	5.2 oz.
Gold	....	....	1.62 oz.

Smaltite occurs in a calcite vein in granite at Gothic, Colorado.

Near Blackbird, Lemhi county, Idaho, lenticular bodies of cobalt-nickel ore occur in pre-Cambrian schists and quartzites which are cut by diabase and lamprophyre dikes.

In Los Angeles county, California, cobalt silver ores are found in barytic lodes.

[1] Analysis made by A. G. Burrows, Ontario Bureau of Mines.

[2] Mineral Industry, Vol. XIV, 1905, p. 461.

The following table shows the cobalt oxide produced and imported into the United States:

PRODUCTION AND IMPORTS OF COBALT OXIDE.[1]

Year (*a*)	Production pounds	Imports pounds	Year (*a*)	Production pounds	Imports pounds
1869	811	....	1894	6,763	24,020
1870	3,854	....	1895	6,400	36,155
1871	5,086	....	1896	12,825	27,189
1872	5,749	....	1897	19,300	24,771
1873	5,128	1,480	1898	9,640	33,731
1874	4,145	1,404	1899	10,200	46,791
1875	3,441	678	1900	12,270	54,073
1876	5,162	4,440	1901	13,360	71,969
1877	7,328	19,752	1902	20,870	79,984
1878	4,508	2,860	1903	120,000	73,350
1879	4,376	7,531	1904	22,000	42,353
1880	7,251	9,819	1905	(*b*)	70,048
1881	8,280	21,844	1906	....	41,084
1882	11,653	17,758	1907	....	42,794
1883	1,096	13,067	1908	100,000	1,550
1884	2,000	25,963	1909	....	9,818
1885	8,423	16,162	1910	....	6,124
1886	8,689	19,366	1911	....	22,934
1887	5,769	26,882	1912	....	31,848
1888	7,491	27,446	1913	....	28,729
1889	12,955	41,455	1914	....	109,484
1890	6,788	33,338	1915	....	190,145
1891	7,200	25,483	1916	....	238,934
1892	7,869	32,833	1917	....	236,822
1893	8,422	28,164			

[1] Mineral Industry.

(*a*) Production is stated for calendar years; imports for fiscal years ending June 30 until 1887, and for calendar years subsequently.

(*b*) Since 1904, with the exception of 1908, no record is given of any cobalt oxide having been produced in the United States. However, since 1905, the total production of mixed cobalt and nickel oxides of the cobalt smelter of the Canadian Copper Co. was shipped to the United States to be refined. The amount recovered from this source may be closely approximated by referring to the production of the Canadian Copper Company. See section entitled "Metallurgy of Cobalt."

The annual consumption of cobalt oxide in the United States amounts to approximately 200,000 pounds, and although the sum of the figures in the table does not equal this amount, except in a few years, this is merely because the cobalt materials imported were classified as some product other than cobalt oxide, e.g. cobalt ore, and zaffer. Zaffer is a term applied to finely-ground roasted cobalt ores or products.

In 1913 the import duty on cobalt oxide was reduced from 25 to 10 cents per pound.

Mexico

Cobalt-bearing minerals have been found at several localities in Mexico, but little has been published concerning these occurrences. Near the village of Pihuamo in the state of Jalisco, cobalt minerals occur in veinlets cutting a large vein of magnetite associated with pyrite and pyrrhotite. The chief rock in the vicinity is described as andesite. It is said that a number of tons of ore containing 8 or 9 per cent. of cobalt were mined in this district. The minerals are cobaltite and

small quantities of smaltite and cobalt bloom. The vein matter consists of greenish calcite, and a little barite. Niccolite also appears to be present.

The following Mexican localities are also reported to contain cobalt minerals: Iturbide, in Chihuahua; Guanacevi, in Durango; Cosala, in Sinaloa; at the Mirador mine in Jalisco. Small shipments of ore containing 30 per cent. of cobalt and 7 per cent. of nickel were made from the Esmeralda and Pihuano mines in Jalisco. A pink cobaltiferous variety of smithsonite occurs at Boleo, Lower California. An article dealing with the cobalt deposits in Jalisco has been published by Navarro, Mem. y Rev. Soc. Cientif., Antonio Alzate, vol. 25, 1907, pp. 51-57.

Peru

Nickel and cobalt minerals are reported to occur in the Department of Cuzco.

Chile

Nickel and cobalt minerals are found associated with the ores of silver at several places in Chile. Among these are Mina Blanca de San Juan, Department of Freivna, Province of Atacama; Minillas, Cambillos Brutre, in the Province of Coquimbo; and Tajon del Yeso, in the Province of Santiago. The ores of the Colorado mine of Chanaicillo are nickel-bearing. Veins of nickel ore are found also at San Pedro, near Flamenco, a small port south of Chanaial.

During the latter part of 1901 shipments of cobalt ores were made from Caldera to the United Kingdom, and it was anticipated then that the returns would show sufficient profit to render the re-opening of the mines advisable.

The San Juan group of mines, lying north of the Port of Peña Blanca are located on well formed lodes varying from one to six feet in width. The ore consists of oxide, arsenate, and sulpharsenide of cobalt with an average content of about 4 per cent. of cobalt. The workings reached a depth of 120 to 200 feet.

Cobalt mines[1] were operated in the Provinces of Atacama, Coquimbo, and Aconcagua. The production in 1903 was 284 metric tons of 7.15 per cent. ore. The largest producer was the Rosa Amelia mine, situated in the Department of Freivna, Atacama, this mine in 1903 producing 133 tons of ore. In the Goyenechea mine, in the Department of Chanaial, an argentiferous cobalt ore was mined carrying 8 per cent. of cobalt.

Mining of cobalt glance and erythrite was also carried on at Tambillos and Huasco.

The quantity of cobalt ores mined in Chile between 1844 and 1905 was 6,384 tons.

Argentina

A cobalt deposit was discovered in 1904 at Valla Hermoso, Vinchina, Provincia de la Rioja, Argentina, and was worked on a small scale.[2] The ore occurs on the western slope of the Cerro de Famantina, a spur of the Andes, in a talcose schist, usually near its contact with an acid, igneous rock. A number of veins appear at the surface, but only one has been exploited. The ore body varies in width from 0.9 m. to 1.3 m., with an average of about 1.1 m. The ore consists of cobaltite and

[1] Mineral Industry, Vol. XIII, 1904, p. 338.
[2] Mineral Industry, Vol. XIII, 1904, p. 336.

arsenopyrite in a gangue of quartz. This was hand-cobbed into first and second class ores. The first class assayed 6.0 to 7.0 per cent., and the second class, 3.0 to 4.5 per cent. cobalt. The first class contained 0.75 to 1.0 oz of gold and 5 to 10 oz. of silver per ton. About 300 tons were produced, of which 150 were hand-cobbed, and of this only a few tons were first class ore. The distance of this property from Monozasta, which is the nearest railway station on the F. C. A. Del Norte line, is 120 miles. All the ore that was concentrated was shipped to England.

Great Britain

For many years small supplies of cobalt ore were obtained from the mines at Moel Hiraddug, near Rhyl; Cornwall; in Flintshire, and Cumberland. However, no production is recorded since 1890.

From 1860 to 1890 there were produced 1,242 tons of cobalt and nickel ore valued at $36,710.

Spain

Mining of cobalt ores was carried on in Spain between 1871 and 1897 in the Valley of Gistain, Huesca, near the French frontier. At Guadalcanal, in Andalusia, veins containing ores of silver, cobalt, and sometimes copper, in a calcite gangue, were at one time important. However, only small quantities were produced, as may be seen from the following table:

PRODUCTION OF COBALT ORES IN SPAIN.

Year	Cobalt Ore		Year	Cobalt Ore	
	tons	value		tons	value
		$			$
1871	4	....	1887	436	13,914
1872	40	....	1888	68	5,476
1873	4	....	1889	141	4,876
1874	82	....	1890	111	4,368
1875	89	....	1891	60	1,804
1876	115	....	1892	24	72
1877	433	....	1893	18	194
1878	100	....	1894	52	624
1879	110	....	1895	7	84
1880	129	....	1896	18	1,800
1881	102	13,720	1897	13	3,400
1882	40	5,234	1898	....	....
1883	19.4	2,486	1899	....	....
1884	....	....	1900	....	....
1885	....	....	1901	....	....
1886	132	17,200			

Russia

A deposit of cobalt ore, free from nickel, occurs at Dachkessan, Government of Elizabethpol. This deposit is in the form of a dike of diorite impregnated with cobalt minerals associated with iron and copper pyrites. The workings are now abandoned.

China

Very little is known of any cobalt deposits in China. Bowler[1] states that cobalt ore is found at the base of a range of sandstone hills near the town of Tsangscheng, the geological formation being probably Upper Cambrian. These deposits are now either exhausted or very little worked.

Further information about the treatment of these ores will be found under the "Metallurgy of Cobalt."

Ontario, Canada[2]

Situation and Discovery

The ore bodies at Cobalt, which carry silver, cobalt, nickel, and arsenic, were discovered in 1903 during the building of the Timiskaming and Northern Ontario railway. The first of these deposits to be worked lies within half a mile of Cobalt station, which is about 330 miles north of Toronto. One of the oldest known ore bodies in North America, the argentiferous galena on the east side of Lake Timiskaming, is distant only eight miles from Cobalt station. This galena deposit, known as the Wright mine, was apparently discovered by voyageurs over 150 years ago.

It may be added that the building of the Canadian Pacific railway exposed the Sudbury nickel deposits 90 miles southwest of Cobalt. It can thus be said that each of the two railways in this part of Ontario, brought to light an important mineral field.

The Sudbury deposits have received a great deal of attention from geologists of this and other continents. One group, among whom may be mentioned Barlow,[3] Coleman,[4] and Vogt, regard them as due to magmatic segregation from an original igneous magma, without further concentration. Another group, among whom are Dickson,[5] Beck,[6] and Knight,[7] contend that these deposits are the result of aqueous igneous action, and that the sulphides were deposited after the accompanying rocks were formed.

Before proceeding to a consideration of the cobalt veins, a table showing the age relations of the rocks at Cobalt is given below.

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[1] Bowler, Chinese Treatment of Cobalt Ores. Chemical News, Vol. LVIII, 1888, p. 100.

[2] Miller, Willet G., The Cobalt-Nickel Arsenides and Silver Deposits of Timiskaming, Ontario. Reports of Bureau of Mines, Ontario: Vol. XIV, Pt. II, first edition, 1905; second edition, 1906; third edition, 1908; fourth edition, Vol. XIX, Pt. II, 1913. The larger part of the description of the deposits at Cobalt is taken from Dr. Miller's reports.

[3] Barlow, Nickel and Copper Deposits of the Sudbury Mining District. Geol. Survey of Can., 1901, Pt. H.

[4] Coleman, The Sudbury Nickel Region, Ontario Bureau of Mines, Vol. XIV, 1905, Pt. III; The Nickel Industry, with Special Reference to the Sudbury Region, Ontario, Department of Mines, Ottawa, 1913.

[5] Dickson, The Ore Deposits of Sudbury, Ontario. Am. Inst. Min. Eng. Trans., Vol. XXXIV, 1904, pp. 3-67.

[6] Beck, The Nature of Ore Deposits, p. 41.

[7] Knight, Origin of Sudbury Nickel-Copper Deposits. Eng. and Min. Jour., Vol. CI, 1916, p. 811; also Report Royal Ontario Nickel Commission, 1917.

Age Relations of Rocks of Cobalt and Adjacent Areas [1]

PALEOZOIC
Silurian
Niagara

(*Great unconformity*)

EOZOIC OR PRE-CAMBRIAN
Later Dikes

Nipissing Diabase
(*Intrusive contact.*)

Cobalt Series
(*Unconformity*)

Lorrain Granite
(*Intrusive contact.*)

Lamprophyre Dikes
(*Intrusive contact.*)

Timiskaming Series
(*Unconformity*)

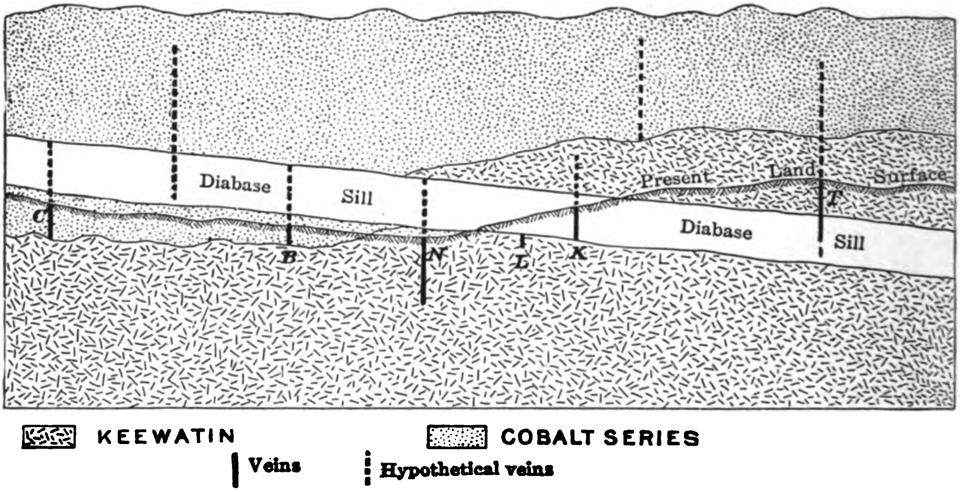
Keewatin Complex

Character and Origin of Cobalt Veins

The deposits at Cobalt occupy narrow, practically vertical fissures, and joint-planes in the metamorphosed Cobalt series. A few productive veins of similar form have been found in the intrusive Nipissing diabase. Others occur in the Keewatin, which is the oldest series of the area, and which consists of basic volcanic rocks. The most productive veins in the Keewatin have been No. 26 on the Nipissing and the vein system on the Timiskaming-Beaver. The former vein lies close to the western edge of the diabase sill. Before erosion of the sill took place, vein No. 26 lay beneath the sill or in its foot-wall. The Timiskaming-Beaver veins, on the other hand, lie in the upper or hanging wall of the sill. There are veins which run from the conglomerate and other fragmental rocks of the Cobalt series into the underlying Keewatin; and there are veins, e.g. the Nova Scotia and Timiskaming veins, which run downward from the Keewatin into the underlying, intrusive Nipissing diabase. A vein on the Cobalt Central passes from the surface downward through the Nipissing diabase into the Cobalt series, which here forms the foot-wall of the diabase sill. Moreover, " blind " veins, or veins that do not outcrop at the surface, have been worked on several properties. One of the most interesting of these occurs beneath Peterson lake. This vein is in the Keewatin, which is here overlain by the Nipissing diabase sill. The vein runs up to the bottom of the sill, but not into it. The figure on page 24 shows the relationship of the rocks and the type veins described.

[1] Miller, W. G., The Cobalt-Nickel Arsenides and Silver Deposits of Timiskaming, Ontario, fourth edition, Ont. Bur. Min., Vol. XIX, 1913, Pt. II, p. 48.

The veins of most of the producing mines lay below the diabase sill before it was eroded, e.g., those on the Coniagas, Nipissing, Hudson Bay, Trethewey, Buffalo, Mining Corporation, Crown Reserve, Drummond, Lawson at Kerr lake, LaRose and McKinley-Darragh at Cobalt lake. The King Edward, Silver Cliff, and some of the O'Brien veins lie within the sill. In the outlying camps good examples of veins occurring in the sill are the Wettlaufer of South Lorrain, and Miller-Lake O'Brien of Gowganda.



Generalized vertical section through the productive part of the Cobalt area.

The section shows the relations of the Nipissing diabase sill to the Keewatin and the Cobalt series, and to the veins. The eroded surface is restored in the section. The sill is less regular than the illustration shows it to be.

B and C represent a large number of veins that are in the fragmental rocks, Cobalt series, in the lower or foot-wall of the eroded sill. N represents a type of vein, such as No. 26 on the Nipissing, in the Keewatin below the eroded sill, and L a type such as one under Peterson lake, in the Keewatin foot-wall, but not extending upward into the sill; K, a vein in the sill itself, such as No. 3 on the Kerr Lake property; T, a vein such as that on the Timiskaming or Beaver properties, in the Keewatin hanging wall and extending downward into the sill.

At Diabase mountain the top of the hill is diabase, while the rocks below the diabase are composed of slates and conglomerates lying on Keewatin greenstones, so that certain veins, as on the Penn-Canadian and Bailey, started in the sill and continued downward into the underlying rocks.

At the Timiskaming shaft the upper contact between the Keewatin and the diabase is approximately 575 feet from the surface. Along this contact, both above and below, the Timiskaming and Beaver mines have recovered their richest ores. In order to ascertain the thickness of this diabase sill it was diamond-drilled, and the lower contact between the diabase and the Keewatin formations was found at an approximate depth of 1,670 feet from the surface, showing the sill to have a thickness of about 1,100 feet. After diamond drilling was finished, a shaft was sunk through the sill. Exploration work from this shaft, conducted along the bottom of the sill and in the rocks immediately below, has failed to disclose economic ore bodies up to the autumn of 1918.

The following paragraphs, regarding the origin of the ores at Cobalt, are copies from W. G. Miller's report.[1]

The material in the veins at Cobalt has, in all likelihood, been deposited from highly heated and impure waters which circulated through the cracks and fissures of the crust and probably were associated with—followed—the Nipissing diabase eruption.

The waters are said to be associated or connected with the diabase eruption in the sense that they probably represented the end product of the eruption. In many volcanic regions, hot springs are present long after the rocks have solidified. In the Cobalt area the fissures and joints now occupied by the ores were probably produced by the gradual shrinkage in cooling of the diabase, the ores being deposited by the waters which represented the last stage of vulcanicity.

It is rather difficult to predicate the original source of the metals—silver, cobalt, nickel, arsenic, and others—now found in these veins. They may have come up from a considerable depth with the waters, or they may have been leached out of what are now the folded and disturbed greenstones and other rocks of the Keewatin. Analyses of various rocks of the area have not given a clue to the origin of the ores. However, the widespread occurrence of cobalt veins in the diabase, or in close association with it, shown by discoveries throughout a region three thousand square miles or more in extent, appears to be pretty conclusive proof that the diabase and the ores came from one and the same magma.

As the ore bodies in the vicinity of Cobalt station, and elsewhere in Ontario, may be said to be unique among those known in North America, we have no chance of instituting comparisons on this continent. Some European veins, however, such as those of Annaberg, Joachimsthal and other localities[2] show a similar association of minerals.

These European ores are considered by most authors to be genetically connected with intrusions of granite. At Joachimsthal the veins are said to be cut across by basic dikes, and there is evidence to the effect that at the time of the eruption of the dikes the vein formation had not yet been completed. Since especially nickel and cobalt minerals are characteristically connected with basic rocks, the question arises as to whether the European ores mentioned may not be more closely connected in origin with basic rocks than they are considered to be. There may be deeper seated intrusions of these rocks slightly older than the dikes.

Ores and Minerals

The most important ore in the veins at Cobalt is native silver, associated with which is usually some dyscrasite, argentite, pyrargyrite and other compounds of silver, smaltite, niccolite, and related minerals. Many of the minerals occur mixed in the ores and for this reason some of them have not been clearly identified. Another feature of the minerals, which renders their identification difficult, is the fact that most of them occur in the massive form. Crystals when present are small, being frequently almost microscopic in size. The following minerals have been identified and can be conveniently classed under the headings:

I. Native Elements.—Native silver, native bismuth, graphite.

II. Arsenides.—Niccolite, $NiAs$; chloanthite, $NiAs_2$; smaltite, $CoAs_2$; and löllingite, $FeAs_2$.[3]

III. Arsenates.—Erythrite, or cobalt bloom $Co_3As_2O_8.8H_2O$; annabergite, or nickel bloom $Ni_3As_2O_8.8H_2O$; scorodite, $FeAsO_4.2H_2O$.

IV. Sulphides.—Argentite, Ag_2S; millerite, NiS; argyropyrite?; stromeyerite? $(Ag,Cu)_2S$; bornite, Cu_5FeS_4; chalcopyrite, $CuFeS_2$; sphalerite, ZnS; galena, PbS; pyrite, FeS_2.

V. Sulpharsenides.—Mispickel, $FeAsS$; cobaltite, $CoAsS$.

VI. Sulpharsenites.—Proustite, Ag_3AsS_3; xanthoconite? Ag_3AsS_3.

[1] Miller, W. G., Ont. Bur. Min., Vol. XIX, 1913, Pt. II, p. 8.

[2] See description, page 6.

[3] Ellsworth, A Study of Certain Minerals from Cobalt, Ontario. Ont. Bur. Min., Vol. XXV, 1916, Pt. 1, p. 223.

VII. Antimonides.—Dyscrasite, Ag_6Sb; breithauptite, NiSb.
VIII. Sulphantimonites.—Pyrargyrite, Ag_3SbS_3; stephanite, Ag_5SbS_4; polybasite? Ag_9SbS_6; tetrahedrite, $Cu_8Sb_2S_7$; freibergite? (silver bearing tetrahedrite).
IX. Sulphobismuthites.—Matildite, $AgBiS_2$, emplectite, $CuBiS_2$.
X. Mercury.—Amalgam (?).
XI. Phosphate.—Apatite.
XII. Oxides.—Asbolite; heubachite?; heterogenite?; arsenolite, As_2O_3; roselite? $(Ca,Co,Mg)_3As_2O_8.2H_2O$.
XIII. Veinstones.—Calcite, dolomite, aragonite, quartz, barite, fluorite.[1]

The above table contains a few minerals that have been found in only one or two veins and cannot be considered characteristic. Millerite, for instance, is of rare occurrence, and emplectite has been found only in the Floyd mine, near Sharp lake, in the western part of the Cobalt area. Bornite, chalcopyrite, zinc blende, galena and pyrite are not characteristic of most of the ore, these minerals occurring more frequently in the wall rock or in non-silver bearing ore of the Keewatin. Apatite in recognizable crystals has been found in the ore of only one mine. Mercury appears to occur in the ore of all the mines that contain high values in silver, but whether it occurs only as amalgam or in other forms has not been determined.

A question-mark has been placed after the names of several minerals in the table which have been reported to occur in the veins, but whose identification has not been made complete by chemical analyses or crystallographic measurements. Gold in small quantity has been found in a number of veins, especially in those in which cobaltite or mispickel are characteristic minerals.

Certain shipments from the Timiskaming mine contained copper in economic quantities.[2]

While we have both native silver and arsenides in abundance, the compounds of arsenic and silver occur only in small quantities. Antimony, which is not abundant, is found in some compounds where we would expect to find arsenic, since the latter is so much more common.

One would also expect to find more compounds of bismuth, since this metal occurs in the free state in considerable quantities in some of the deposits. It might also be expected that native arsenic would occur, but so far it has not been found.

Nearly all the chemical groups of minerals found in the celebrated Joachimsthal deposits of Bohemia are present in the Timiskaming ores. The most important exception is uraninite or pitchblende, which came into prominence a few years ago as the chief source of the element radium.

Order of Deposition of Minerals

The following table shows, in descending order from the youngest to the oldest, the general succession in order of deposition of the principal minerals of the Cobalt area proper. There appear to be, however, minor exceptions to this order.

[1] Barite and fluorite have not been found in the veins at Cobalt proper, but they occur with silver-cobalt ores in one or two veins near Elk lake, and in Langmuir township in the southeast part of the Porcupine area. Small veins of barite have also been found in the Nipissing-diabase in Leonard and Lawson townships, in the Gowganda silver area.
[2] Miller, W. G., Ont. Bur. Min., Vol. XIX, 1913, Pt. II, p. 10.

III. Decomposition products, e.g. erythrite or cobalt bloom, annabergite or nickel bloom, and asbolite.

II. Rich silver ores and calcite.

I. Smaltite, niccolite, and dolomite or pink spar.

After the minerals of group I were deposited the veins were subjected to a slight movement. In the cracks thus formed the minerals of group II were deposited. A few veins that escaped the disturbance do not contain silver in economic quantity.

This order of deposition appears to be the same as that of the minerals in the Annaberg deposits of Germany and those of Joachimsthal, Austria.[1]

Messrs. Campbell and Knight[2] subjected specimens of the cobalt-silver ores of Cobalt to examination, using methods employed in metallography. While their results confirm, in a general way, Miller's observations on hand specimens, and on blocks of ore, they have worked out the order of deposition of the minerals in greater detail. They state that, although all of the structures met with in this examination cannot be satisfactorily explained, they point to the following order of deposition for the principal constituents. First came the smaltite, closely followed by the niccolite; other minerals in small amount came down at this time. Then, after a period of slight movement in which the first minerals were more or less fractured, calcite was deposited as a ground-mass. Later came argentite, which was followed by native silver and native bismuth. Lastly came the surface decomposition products, erythrite and annabergite.

Arranged in order, the succession is, then, as follows:

Smaltite, niccolite, period of movement and fracturing, calcite, argentite, native silver, native bismuth, period of decomposition, and finally erythrite and annabergite.

At Annaberg, bismuth ore is thought to have been deposited with the cobalt-nickel minerals and not with the rich silver ore. Moreover, at the time Messrs. Campbell and Knight made their examination of the ores from Cobalt it was not known that two carbonates occur in the gangue, viz., calcite (white) and dolomite (pink). The latter has been found to belong to an older generation than the former.

Any statement as to the form in which the native silver came in solution into the veins must be merely hypothetical. Silver carbonate, Ag_2CO_3, like calcium carbonate, $CaCO_3$, is soluble in excess of carbon dioxide, CO_2. Hence when the calcite, $CaCO_3$, of the cobalt-silver veins was being carried in solution, it does not seem improbable that silver carbonate may have been in solution at or about the same time.

Palmer and Bastin[3] discuss metallic minerals as precipitants of silver and gold, and their experiments show that certain sulphides and arsenides of copper and

[1] Beck, The Nature of Ore Deposits, Weed's translation, pp. 285-289.

[2] Campbell and Knight, Microscopic Examination of the Cobalt-Nickel Arsenides and Silver Deposits of Timiskaming. Economic Geology, Vol. I, 1906, pp. 767-776. The Paragenesis of the Cobalt-Nickel Arsenides and Silver Deposits of Timiskaming. Eng. and Min. Jour., Vol. LXXXI, 1906, p. 1089.

[3] Palmer and Bastin, Metallic Minerals as Precipitants of Silver and Gold. Economic Geology, Vol. VIII, 1913, p. 140.

nickel, e.g. chalcocite and niccolite, precipitate metallic silver very efficiently from dilute aqueous solutions of silver sulphate. However, the more common sulphides, such as pyrite, galena, and sphalerite were relatively inactive as precipitants of silver from aqueous sulphate solutions.

Argentite, proustite, and native silver in hair-like form, appear to be of secondary origin. These minerals are found in vugs in the lower workings of the mines where the ore has become leaner, or below the productive zone in the veins.

The silver-bearing solutions working downward beneath the sill, in the fractured rocks, lost their silver content by precipitation on coming in contact with the cobalt-nickel minerals before a great depth was reached. Hence it is not surprising to find that rich silver ore does not extend to as great a depth beneath the sill as do the cobalt-nickel ores. Practically all the samples of native silver, excepting those that show a crystalline form or occur in veinlets, contain mercury.

Cobalt minerals are also found in areas lying at some distance from the town of Cobalt. The most important deposits occur in South Lorrain, Casey township, and Gowganda. The Lake Superior silver deposits also contain small amounts of cobalt.

Other minor occurrences of nickel-cobalt ores in Canada are given in the "Annual Report of the Geological Survey of Canada," vol. XIV, 1901, pt. H, to 1917.

The following table shows the production of the Cobalt district from 1904 to 1917.

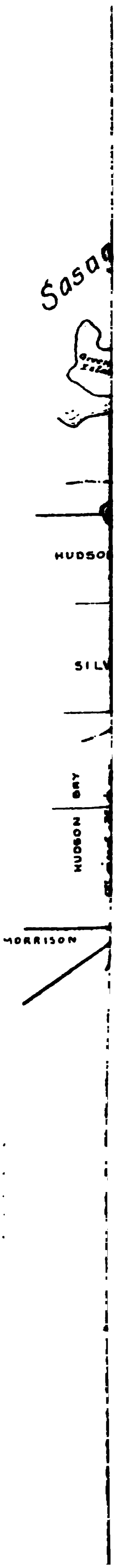
Total Production of Cobalt Mines 1904-1917[1]

Year	Nickel		Cobalt		Arsenic		Silver		Total value
	tons	value	tons	value	tons	value	ounces	value	
		$		$		$		$	$
1904..	14	3,467	16	19,960	72	903	206,875	111,887	136,217
1905..	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906..	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907..	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908..	612	....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909..	766	....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
1910..	504	....	1,098	54,699	4,897	70,709	30,645,181	15,478,047	15,603,455
1911..	392	....	852	170,890	3,806	74,609	31,507,791	15,953,847	16,199,346
1912..	429	14,220	934	314,381	4,166	80,546	30,243,859	17,408,935	17,818,082
1913..	377	13,326	821	420,386	3,663	64,146	29,681,975	16,553,981	17,051,839
1914..	(a) 90	28,978	(a) 351	590,406	2,030	116,624	25,162,841	12,765,461	13,501,469
1915..	(b) 35	28,353	(b) 206	383,261	2,490	148,379	24,746,534	12,135,816	12,695,809
1916..	(b) 79	59,380	(b) 400	805,014	2,160	200,103	19,915,090	12,643,175	13,707,672
1917..	(b) 155	125,071	(b) 337	1,138,190	2,592	608,483	19,401,893	16,121,013	18,028,597
Total.	4,058	283,969	8,950	4,388,400	38,789	1,524,569	274,724,172	151,950,561	158,176,339

[1] Ont. Bur. Min., Vol. XXVII, 1918, p. 16.

(*a*) Metallic contents of nickel and cobalt oxides respectively.

(*b*) Metals and metallic contents of all nickel and cobalt compounds.



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In the following table a record of silver shipments since 1904 is given.

Silver Production, Cobalt Mines, 1904 to 1917[1]

Year	No. of producing mines	Shipments and Silver Contents								
		Ore		Av. per ton	Concentrates		Av. per ton	Bullion	Total	
		tons	ounces	ounces	tons	ounces	ounces	ounces	ounces	value
										$
1904	4	158	206,875	1,309	......	....	......	....	206,875	111,887
1905	16	2,144	2,451,356	1,143	......	....	......	....	2,451,356	1,360,503
1906	17	5,335	5,401,766	1,013	......	....	......	....	5,401,766	3,667,551
1907	28	14,788	10,023,311	677	......	....	......	....	10,023,311	6,155,391
1908	30	24,487	18,022,480	736	1,137	1,415,395	1,244	....	19,437,875	9,133,378
1909	31	27,729	22,436,355	809	2,948	3,461,470	1,174	....	25,897,825	12,461,576
1910	41	27,437	22,581,714	821	6,845	7,082,834	1,030	980,633	30,645,181	15,478,047
1911	34	17,278	20,318,626	1,176	9,375	8,056,189	858	3,132,976	31 507,791	15,953,847
1912	30	10,719	15,395,504	1,436	11,214	9,768,228	871	5,080,127	30,243,859	17,408,935
1913	35	9,861	13,668,079	1,386	11,016	8,489,321	770	7,524,575	29,681,975	16,553,981
1914	32	4,302	6,504,753	1,511	12,152	8,915,958	733	9,742,130	25,162,841	12,765,461
1915	24	2,865	6,758,286	2,359	11,996	10,001,548	834	7,986,700	24,746,534	12,135,816
1916	28	2,177	4,672,500	2,146	8,561	7,598,011	887	7,644,579	19,915,090	12,643,175
1917	28	2,288	3,271,353	1,429	13,720	6,445,243	469	8,053,318	19,401,893	16,121,013
To'l.	....	151,568	151,712,958	1,001	88,964	71,234,197	801	50,145,038	274,724,172	151,950,561

As the camp has developed, the average grade of ore shipped has gradually lowered in value. The introduction of concentration plants in 1908 has tended to keep the shipments up to a high standard, but there is a growing tendency to treat the ore at the mines and recover the silver as bullion for shipment. The average concentration ratio of the different mills during 1914 was 47-1.. Further information on the treatment of the ores at Cobalt will be found under the heading "Development of the Metallurgy of the Silver-Cobalt Ores of Ontario."

In the purchasing of the cobalt ores payment is made for the silver and in some cases for the cobalt, the amount paid for the silver varying with the grade of the ore. The different schedules that have been adopted are given in the descriptions of the Coniagas Reduction Co. and the Deloro Mining and Reduction Co. under the "Metallurgy of Cobalt."

In 1905 the price offered for cobalt in ores containing about 6 per cent. cobalt, fell from 65 to 35 cents a pound and at the same time the allowance which had been made previously for the nickel and arsenic, viz., 12 and 0.5 cents a pound respectively was cancelled.

Between 1905 and 1909, ten cents per pound was allowed for the cobalt in the ores if they contained more than 6 per cent., except where the nickel was greater than the cobalt.

Between 1909 and 1914 very little was realized for the cobalt except in the case of high grade ores.

Since 1914, some of the companies have been paying for cobalt, but in some cases not for silver in the same ore. The amount paid for cobalt varies with the

[1] Ont. Bur. Min., Vol. XXVII, 1918, p. 16.

grade of the ore and is about as follows: five cents a pound for the cobalt in ores between 6 and 8 per cent., ten cents a pound in ores between 8 and 10 per cent., and fifteen cents a pound in ores over 10 per cent. cobalt.

Most of the cobalt ores that are purchased for the recovery of the cobalt are treated by Canadian smelters. However, a quantity of ore is imported by smelters in the United States, the chief importer being the American Smelting and Refining Company. The Pennsylvania Smelting Co., Carnegie, Pa.; the Balbach Smelting and Refining Co., Newark, N.J.; and the United States Metals Refining Co., Chrome, N.J., also import small quantities of cobalt ores.

Shipments of cobalt-nickel residues from the Nipissing high-grade mill containing 9 per cent. cobalt and 4.5 per cent. nickel have been made by the Nipissing Mining Co. to H. Wiggin and Co., Birmingham, England.

A few shipments containing 4,500 ounces of silver per ton were made previous to 1913 to the Government smelter, Saxony, Germany.

United States smelters imported during 1915, 7,310 tons of ore from the Cobalt district containing 3,580,843 fine ounces of silver, as against 7,206 tons containing 3,966,301 fine ounces in 1914.

In 1916 shipments of ore and concentrates from Cobalt to refineries in the United States comprised 364 tons of ore carrying 408,014 ounces, and 3,700.35 tons of concentrates carrying 1,629,841 ounces—a total of 2,037,855 ounces of silver. In 1917 to refineries in the United States there were consignments from Cobalt amounting to 6,307 tons, from which 2,914,267 fine ounces of silver were recovered. These shipments were on the whole of considerably lower grade than those to the home refineries, averaging only 462 ounces of silver to the ton, as against 810 ounces. Much the larger quantity treated by U. S. plants was at the works of the American Smelting & Refining Company, Denver, Col., and Perth Amboy, N.J. Of the total quantity of silver contained in the product of the Cobalt mines in 1917, namely 19,401,893 ounces, 14,504,681 ounces were refined at the mines in Cobalt or in Ontario works, being about 75 per cent. of the whole.

Additional References

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CHAPTER II

THE METALLURGY OF COBALT

Very little is known about the details of the metallurgy of cobalt in comparison with our knowledge of the other metals, except by those directly connected with the industry. It is not a new subject, since the treatment of cobalt ores was practised for several hundred years in Europe, where the output of the world's supply of cobalt was controlled until the discovery of the Canadian cobalt deposits in 1903. New South Wales, Norway, New Caledonia, Germany, Chile, and Hungary were the chief producers of cobalt ores, while the largest refineries were located in Germany and England. Since 1902 there has been very little cobalt ore mined outside of Canada, except in the United States during 1903 and 1908, when there was a production of 60 and 100 tons respectively of cobalt oxide from the ores of Missouri. Until 1913, the world's annual production of cobalt oxide amounted to approximately 250 tons, but within recent years the production has increased until in 1916 it amounted to 400 tons. Within the last few years the quantity of cobalt metal produced has increased from practically nothing in 1913, to 165 tons in 1916, and 158 tons in 1917.

The price of cobalt oxide (70 per cent. cobalt) fluctuated little previous to 1907, the oxide selling at prices varying from $1.60 to $2.00 a pound. In 1907 the price rose to $2.50, but in 1908 it dropped to $1.40. Since 1908 the price has gradually declined, the average for 1915 being 90 cents a pound. Owing to the increased present demand the price has risen to $1.50 (1917). The value of metallic cobalt is given (1917) as $2.00 to $2.25 a pound.

In reviewing the metallurgy of cobalt, two noticeable changes are evident; first, previous to the discovery of the large cobalt deposits in Canada, practically all compounds of cobalt were produced in Europe; and second, in the European refineries ores were treated for the cobalt content alone, while from the ores of Canada, metallic silver, cobalt, nickel, and arsenic oxide are recovered. The associated metals are often a source of revenue for the smelters.

Since most of the cobalt compounds produced in Europe were used in the ceramic industries, and as the requirements of these industries at the time were not such as to demand a high-grade cobalt oxide, it is reasonable to conclude that the processes used in Europe did not produce a high-grade cobalt oxide. However, the demand of the ceramic industries at the present time is for a high-grade oxide, and this is supplied by the Canadian smelters at practically one-half the price that the low and medium cobalt compounds or smalts were sold at in Europe ten years ago.

The elements arsenic, sulphur, copper, iron, and nickel, which are usually associated with cobalt ores, are common to the ores of Europe and Canada, while those from New Caledonia, though free from sulphur and arsenic, contain a large percentage of manganese. However, arsenic and sulphur cannot be altogether considered as impurities in cobalt ores, since the presence of either element enables the ores to be reduced in blast-furnaces to produce a speiss or matte.

The metal cobalt or the oxide has never been recovered in a pure form from ores by dry methods alone, because of its association with metals possessing very similar properties; hence we find chemical or wet methods employed to separate the associated elements. In any preliminary treatment or smelting of cobalt ores the behaviour of cobalt, nickel, and iron toward arsenic, sulphur, and oxygen is important. Of the three metals nickel, cobalt, and iron, nickel has the greatest affinity for arsenic, then cobalt, and lastly iron; while in the case of oxygen their affinities are reversed. As regards the behaviour of these metals towards sulphur, there is little difference, but nickel and cobalt seem to combine preferably with sulphur. Also, because the affinities of the three metals lie very close together, it is not possible to eliminate iron as oxide or silicate from a mixture of iron, nickel and cobalt by having just sufficient arsenic present to form arsenides of nickel and cobalt, nor is it possible to remove iron from the other two in a speiss or matte by regulating the extent of oxidation. In both cases some iron, nickel, and cobalt will be found together.

Cobalt ores are commonly smelted in blast furnaces to remove gangue minerals and other impurities, e.g., iron, sulphur, and arsenic. In the blast furnace smelting, a speiss[1] or a matte[2] and a slag are formed. In blast-furnace smelting of cobalt ores a certain amount of iron is always allowed to enter the speiss or matte, because when iron is present very little cobalt will be found in the slag, while a certain amount of iron is necessary to assist in the subsequent precipitation of arsenic.

The following classification illustrates the metallurgical treatment of cobalt ores. Although the production of smalt[3] directly from ore is not practised at the present time, this method is given in the classification since it was used formerly in Europe.

1. The Extraction of Cobalt Oxide.
    A. Decomposition of arsenical and sulphide ores;
        1. By smelting in blast-furnaces producing,
            (a) A speiss containing chiefly cobalt and nickel arsenides.
            (b) A matte containing chiefly cobalt and nickel sulphides.
        2. By other processes.
            (a) Wet processes.
            (b) Dry processes.
    B. Decomposition of oxidized ores;
        1. Wet processes.
        2. Dry processes.
    C. Decomposition of Silicates.
2. The Production of Smalt.

1.—The Extraction of Cobalt Oxide

A. 1. Decomposition of Arsenical and Sulphide Ores in Blast Furnaces

All the cobalt ores smelted in Canada are arsenical ores containing silver, while those treated in Missouri are sulphide ores practically free from silver.

[1] Speiss is a metallurgical product in which the metals are present as arsenides.
[2] Matte is a metallurgical product in which the metals are present as sulphides.
[3] Smalt is a silicate of cobalt, used in the pottery industries.

From the arsenical silver ores, metallic silver and argentiferous speiss containing cobalt, nickel, iron and copper as arsenides are produced, while from the sulphide ores a matte containing the metals as sulphides is formed. If more than sufficient arsenic or sulphur is present than is necessary to combine with the cobalt, nickel, copper and part of the iron, any excess is removed by a previous roasting, or a number of different ores may be mixed to get the proper quantity of arsenic for the blast furnace charge. The usual blast furnace charge contains approximately 16 per cent. arsenic.

In the blast-furnace smelting of the silver cobalt ores of Canada, the products of smelting are metallic silver, approximately 850 fine, which represents about 85 per cent. extraction of the silver content of the ore; an argentiferous speiss containing arsenides of cobalt, nickel, copper, and part of the iron; a slag containing the lime, magnesia and part of the iron as silicates; and flue dust which contains fine particles of ore, crude arsenious oxide, and coke dust. In smelting sulphide ores, free from silver, matte, slag, and flue dust are produced. The speiss or matte then undergoes further treatment for the recovery of the cobalt, nickel, and silver.

The process of treating speiss or matte consists of grinding and roasting, followed by treatment with sulphuric acid and chemicals to convert the cobalt and nickel into soluble compounds, leaving most of the impurities in an insoluble state. However, small quantities of iron, nickel, copper, arsenic, and sulphur dissolve with the cobalt, and these must be removed, since they are objectionable in cobalt oxide to be used in the ceramic industries. The maximum limits of the above impurities in high-grade cobalt oxide are, approximately, iron 0.5 per cent., nickel 1.0 per cent., copper, arsenic, and sulphur 0.1 per cent each.

Treatment of ground unroasted speiss with acids and chemicals is also practised.

The smelting of arsenical ores of cobalt is conducted in blast-furnaces at present in Canada, chiefly at the smelters of the Deloro Smelting and Refining Company and the Coniagas Reduction Company. The blast-furnace smelting of sulphide ores is used by the Missouri Cobalt Company, Fredericktown, Missouri, which was formerly the North America Lead Company. Sulphide ores were also treated at one time at the Scopello works, Piedmont, Italy; at the Isabella works, in Silesia; at Schneeberg in Saxony; and at the Christofle works, at St. Denis, France.

A. 2 (a). Decomposition of Arsenical and Sulphide Ores by Wet Processes

No methods have ever been successfully practised to treat arsenical and sulphide cobalt ores directly by wet methods alone, the reason being that it is more profitable to concentrate this class of ores by producing a speiss or matte. A few attempts have been made to treat arsenical ores without a preliminary smelting in blast-furnaces, by first roasting the ore, which operation was followed by treatment with acids. Owing to the difficulties in operating such a process, and also to the high consumption of acids and chemicals, only small quantities of ore containing small amounts of soluble gangue minerals could be treated. The reagents tried were hydrochloric, sulphuric, or nitric acids, with or without the addition of chemicals. Solutions of ferrous chloride were also frequently tried.

A. 2 (b). Decomposition of Arsenical and Sulphide Ores by Dry Processes

An attempt was made in Germany to treat low-grade cobalt ores by roasting with the addition of salt and iron pyrites, the cobalt being converted into soluble cobalt chloride, while practically all the iron remained as insoluble oxide. There is no record of such a process ever having been operated on a commercial scale.

B. (1). Decomposition of Oxidized Ores by Wet Processes

The treatment of the ores from New Caledonia comes under this heading. Decomposition of the ore was effected by treatment with a hot solution of ferrous sulphate. For a detailed description of this method see the Herrenschmidt processes.

B. (2). Decomposition of Oxidized Ores by Dry Processes

An attempt was made during 1893 and 1894 to concentrate the oxidized ores of New Caledonia by producing a matte. As these ores did not contain sufficient sulphur to form a matte, this latter element must have been added, probably as pyrites.

C. Decomposition of Silicates

Silicates of cobalt cannot be smelted with arsenical or sulphide ores to form a speiss or matte, because cobalt silicate is not decomposed by iron arsenide or iron sulphide to form cobalt arsenide or sulphide. Nickel silicate, however, does react with iron pyrites to give nickel sulphide and iron silicate. It is possible, however, under strongly reducing conditions, to reduce some cobalt from the silicate.

The possibility of treating silicates by wet methods will depend altogether on whether or not the cobalt and gangue minerals are decomposable by acids. However, there are no known occurrences of cobalt silicates in nature.

As mentioned above, cobalt ores usually contain arsenic, sulphur, copper, iron, nickel, and manganese. The larger part of the arsenic, sulphur, and iron is removed in the preliminary blast-furnace treatment, but the chief difficulty in producing fairly pure cobalt oxide lies in the removal of the remaining small quantities of these elements. The removal of these impurities will be discussed in the order in which they are usually removed from cobalt-nickel solutions.

Removal of Arsenic from Cobalt-Nickel Ores and Solutions

Arsenic is a common impurity of cobalt ores, and is very objectionable, especially in cobalt metal which is added to other metals to make alloys. When dry or wet methods are employed to convert cobalt and nickel into soluble form, considerable arsenic dissolves with the former metals, and any arsenic in solution must be removed before proceeding with the precipitation of the cobalt and nickel.

The method of removing arsenic depends chiefly on the quantity and form in which it is present. In case of large quantities of arsenic, roasting to convert a greater part of it into volatile arsenious oxide is practised, but it is difficult to roast an ore containing more than 20 per cent. of arsenic to below 7 per cent., because of the formation of arsenates of iron, cobalt, and lime. The addition of carbon reduces any arsenates to arsenites, from which compounds volatile arsenious oxide is evolved on heating. This method, however, is too costly for any extensive use.

In case of roasted products or ores containing small quantities of arsenic in the form of arsenates, chemical methods must be used to remove this impurity.

When cobalt ores are treated in blast furnaces, considerable iron is allowed to enter the speiss or matte, so that the loss of cobalt and nickel in the slag will be low. A part of this iron is dissolved with the cobalt and nickel. Any dissolved iron assists in the removal of arsenic, for when a solution containing nickel, cobalt, iron, and arsenic is neutralized with ground calcium carbonate, the iron and arsenic combine to form ferric arsenate, $FeAsO_4$, a light-brown, flocculent to granular precipitate. Practically all the arsenic can be removed in this way, and if there is not sufficient iron in the solution to form ferric arsenate with all the arsenic, iron in some soluble form is added.

Arsenic may also be removed from speiss by heating the roasted product with sodium carbonate and nitre to form soluble sodium arsenate, the metals forming oxides. This method was practised for some time by the Canadian Copper Company, Copper Cliff, Ontario, in the treatment of the silver-cobalt ores. The leached speiss containing up to 3 per cent. arsenic was shipped to New Jersey to be refined.

Removal of Iron

Any iron not removed as ferric arsenate is precipitated by careful additions of calcium carbonate, the iron precipitating as ferric hydrate. To completely precipitate the iron it is essential that the iron be oxidized.

Removal of Copper

Copper, when present in cobalt-nickel solution in quantities over 0.5 per cent., presents considerable difficulty in its complete removal. Small amounts of copper will be precipitated completely from cobalt-nickel solutions along with the iron by the addition of calcium carbonate. However, when the ratio of the copper to the cobalt and nickel is greater than 1 to 6, it is advisable to remove the copper, either by iron plates or electrolytic methods.

Removal of Manganese

There is practically no manganese in the cobalt ores found at Cobalt, Canada, but practically all the cobalt ores from New Caledonia, previously in large use, carried a high percentage of this metal. In the manipulation of the New Caledonia ores the solutions containing cobalt, nickel, and manganese were treated with sodium sulphide, the cobalt and nickel being precipitated as sulphides, while practically all of the manganese remained in solution.

Separation of Cobalt from Nickel

After the arsenic, iron, copper, and manganese have been removed, the next step is to separate the cobalt and nickel. The commonest method is to precipitate the cobalt first, but it is possible to precipitate it after the nickel.

The separation of cobalt from nickel as practised at the present time is practically the same as it was a number of years ago. When a solution of calcium hypochlorite (bleaching powder) is added to a solution containing cobalt and

nickel, the cobalt is precipitated first as a black hydroxide, $Co(OH)_3$. The precipitation may be carried to a colourless solution[1] without precipitating any appreciable quantities of nickel. If it is desired to obtain pure nickel oxide, the first cobalt hydroxide is removed, and the precipitation of the remaining cobalt is continued until the solution is practically free from it, a quantity of black nickel hydroxide, $Ni(OH)_3$, being precipitated at the same time. This intermediate precipitation produces mixed oxides, which must be retreated to produce pure cobalt and nickel oxides. The nickel in solution is precipitated as nickelous hydroxide or hydrated carbonate by the addition of a solution of lime or sodium carbonate.

When cobalt and nickel are present as sulphates, it is customary to precipitate the cobalt by sodium hypochlorite instead of calcium hypochlorite, since the lime of the calcium hypochlorite reacts with the sulphate radicle to form insoluble calcium sulphate, which is difficult to remove. In case calcium sulphate is present in cobalt oxide, it may be removed by a treatment with a hot solution of sodium carbonate, the sodium carbonate and calcium sulphate reacting to form sodium sulphate and calcium carbonate. The sodium sulphate is removed by water and the calcium carbonate by treatment with dilute hydrochloric acid.

Cobalt may also be precipitated after the nickel. In this case soda is added to the boiling solution which precipitates nickel hydroxide and carbonate with a small amount of cobalt carbonate, while cobalt with a small amount of nickel remains dissolved. Cobalt is finally precipitated by additions of more soda or chloride of lime. The writer is not aware of this method being practised commercially.

Methods Used or Proposed to Treat Cobalt Ores for Cobalt Oxide

In the following pages of this section a brief outline is given of the methods practised successfully at the present time and those formerly employed in Europe. This is followed by a summary of all the processes that have been proposed to treat cobalt ores. Very few, if any, of these latter processes could ever be successful on a practical scale, while some are merely laboratory methods. An outline of all the processes is incorporated in this review merely as a reference for anyone undertaking an investigation of the recovery of cobalt from its ores. A more detailed description is given of the processes and smelters of the Coniagas Reduction Company, Limited, and the Deloro Smelting and Refining Company, Limited, since these two smelters are the most successful ones at the present time. The Herrenschmidt process is also considered in detail as a large quantity of New Caledonia ores were formerly treated by this method. All the other processes are grouped together, mention only being made of differences in the proposed treatments that may possibly be of interest.

The methods employed by Canadian companies are first described.

[1] A solution containing approximately 1.5 to 2 parts of nickel sulphate to 1 part of cobalt sulphate is practically colourless. If cobalt is present in a larger ratio, the solutions are pink to red in colour, while if the ratio of the cobalt to nickel is less the solutions are green.

Coniagas Reduction Company Limited[1]

The Coniagas Mines Limited, of Cobalt, Ontario, owns practically all of the issued capital stock of the Coniagas Reduction Co., Limited. The head office of the company is at St. Catharines, Ontario, but the smelter is situated at Thorold, six miles west of Niagara Falls. The company's property comprises 160 acres, of which the smelter occupies about four, with a frontage of 1,500 feet on the Welland canal. It is also served by the Grand Trunk, and Niagara, St. Catharines, and Toronto railways.

The construction of the smelter was begun in March, 1907, and actual smelting commenced in May, 1908. It was erected for the treatment of ores from the Coniagas mine, but its capacity is sufficient to smelt a certain tonnage of other silver ores from Cobalt.

The process in use at this smelter is as follows: The ore is crushed, ground in a Krupp ball-mill, and sampled by a Vezin automatic sampler, two separate samples being taken. The ground ore is smelted in a blast-furnace with limestone and iron ore, the products being impure metallic silver, an argentiferous speiss containing cobalt, nickel, and iron as arsenides, also flue dust, and slag. The impure silver is cast into anodes and refined electrolytically. The speiss is treated with chemicals to recover the silver, cobalt, and nickel. Various grades of cobalt oxide containing from 60 to 76 per cent. metallic cobalt, are produced, according to the demand of the market. The cobalt oxide contains less than 1 per cent. nickel and only small proportions of sulphur, lime, and iron. The arsenical fume from the dust-flues and collectors is treated to produce refined white arsenic, which assays over 99 per cent. arsenious oxide.

To operate the plant, from 200 to 300 horse-power is required, which is transmitted from Niagara Falls. The smelter has a monthly capacity of 250 tons of raw ore. The limestone flux is obtained from Port Colborne, 20 miles south, and the iron ore from Michigan.

This company produces refined silver, cobalt oxide and metal, nickel oxide and metal, white arsenic and metallic arsenic.

The output of the smelter since the commencement of operations is given below. The production of cobalt and nickel oxides, as shown in the table, represents the cobalt and nickel content in refined oxides and various products.

Year	Ore Treated	Silver—Fine	Cobalt Oxide	Nickel Oxide	White Arsenic
	tons	ounces.	tons	tons	tons
1908	266.80	360,683	5.5	1.5	13.5
1909	1,116.90	1,659,604	0.9	....	100.0
1910	2,017.25	3,485,243	53.8	13.2	557.7
1911	2,821.50	5,770,271	60.5	17.3	766.1
1912	2,288.77	4,824,632	129.0	50.7	636.7
1913	2,509.80	4,977,012	250.6	115.6	319.4
1914	1,968.78	3,865,546	171.9	124.9	399.2
1915	2,541.00	3,445,661	59.0	99.8	472.8
1916	2,718.86	4,428,913	190.4	67.6	420.8
1917	2,633.25	2,954,665	49.6	38.9	555.3

[1] Cole, Arthur A., Report of the Timiskaming and Northern Ontario Railway Commission, Toronto, Canada, 1912, p. 69.

The smelting schedule of the Coniagas Reduction Company in condensed form is as follows:

Schedule.—Percentages of silver to be paid for on commercial assay of the silver content per ton of 2,000 pounds as follows:

55 per cent.	for	50 ounces	and proportionate increase in percentage up to	200
73 "	"	200 "	" " " " "	300
78 "	"	300 "	" " " " "	500
84 "	"	500 "	" " " " "	1,000
91.5 "	"	1,000 "	" " " " "	1,500
92.5 "	"	1,500 "	" " " " "	2,000
93.5 "	"	2,000 "	" " " " "	3,000
95 "	"	3,000 and over.		

Sampling to be at vendor's expense.

All ore purchased to be subject to a refining charge of 0.75 cent per ounce of silver content.

Payment:—75 per cent. of the amount 30 days after date of weighing and sampling reports; 25 per cent. of amount 90 days after date of said report.

Price of silver to be determined by New York quotation as given by Messrs. Handy and Harman to Western Union Telegraph Company on dates of settlement.

Deloro Smelting and Refining Company Limited[1]

The Deloro Smelting and Refining Company[2] is a close corporation controlled by M. J. O'Brien,[3] owner of the O'Brien mine, Cobalt, and Miller-Lake O'Brien mine, Gowganda.

The smelter is located at Deloro, Hastings county, Ontario, one mile from Marmora station, on the Canadian Northern railway.

The plant was built and operated first as an arsenic refinery by the Canadian Goldfields, but was entirely remodelled in 1907 by the present owners to smelt ores from Cobalt, particularly those of the O'Brien mine. During the year 1908 a separate and extensive plant was added for the production of cobalt and nickel oxides, and this has been in successful operation since May, 1910. When the plant was first erected the products were limited to silver, refined arsenic, and mixed oxides, but it has beeen gradually extended and at present the company produces refined silver, cobalt oxide and metal, nickel oxide and metal, and white arsenic. There is also an equipment for the production of the cobalt-chromium-tungsten alloy known as stellite, used for high-speed cutting-tools.

Treatment of Ores.—Ores and mill products from Cobalt are purchased on a basis of the silver content. Sampling is done carefully under the supervision of a representative of the seller, the process in use being as follows: Each carload of ore is stored in a separate bin, from which it is removed and crushed to 15-mesh in a ball-mill, to which is attached a Snyder sampler. This machine takes about 50 samples a minute, each one representing 10 per cent. of the ground material leaving the mill. The total sample is subdivided until a final sample of about 20 pounds is obtained. The coarse scales of silver which do not

[1] This company was formerly known as the Deloro Mining and Reduction Company, Limited.

[2] Cole, Arthur A., Report of the Timiskaming and Northern Ontario Railway Commission, Toronto, Canada, p. 74, 1913.

[3] Now M. J. O'Brien, Limited.

pass through the ball-mill screens are melted and cast into a bar which is weighed, sampled and assayed. The final assay of the ore is calculated from the assays of the ore and scales.

The following are typical assays of ores and mill products received at the smelter up to 1915:

Product	Ag per ton Oz.	Co	Ni	Cu	Fe	As	S	SiO_2	CaO	MgO
Ore (hand-picked).......	2,194	7.9	4.3	0.10	5.0	30.2	1.70	4.17	15.0	2.7
Jig product	1,442	10.4	5.8	0.20	6.5	47.2	3.70	4.5	5.2	0.8
Table concentrate.......	1,426	8.2	3.8	0.25	11.6	37.1	8.25	9.5	......	......
Slime "	324	2.1	0.5	......	6.8	10.0	2.98	58.3	2.5	1.92

The ground ore with the required fluxes is mixed in a pug-mill and smelted in a low-pressure blast furnace, the products being metallic silver, an argentiferous speiss, slag, and flue dust.

The silver, which is about 850 parts fine, is charged into an oil-fired refining furnace and the impurities oxidized. Silver 996 parts fine is produced.

The argentiferous speiss is re-crushed, roasted in coal-fired reverberatory furnaces or in an oil-fired Brückner furnace, and the product conveyed to the chloridizing furnaces, where it is heated with salt.

The chloridized speiss is charged into agitating tanks where the silver is extracted by sodium cyanide. Metallic silver is precipitated from the cyanide solution by the addition of aluminum dust. This process was developed by Prof. S. F. Kirkpatrick, Queen's University, Kingston, Canada. The silver obtained is exceptionally high-grade, and the cyanide is to a large extent regenerated. The silver from the refining furnace is mixed with the silver precipitate from the cyanide process and treated with borax and nitre in an oil-fired tilting furnace, after which it is poured into moulds.

The residues from the cyanide treatment are given further treatment for the separation by precipitation of the cobalt and nickel.

Power is supplied to the smelter from Campbellford by the Hydro-Electric Power Commission of Ontario, over a 22-mile transmission line, at $20 per horse-power year. To operate the plant 300 to 400 horse-power is required.

The following table shows the production of the Deloro smelter since 1908:

Year	Ore Treated tons	Silver, Fine ozs.	Cobalt and mixed Oxides tons	Refined Arsenic tons
1908 to 1912..................	11,065	20,339,860	500	3,275
1913..........................	2,920	6,350,500	190	893
1914..........................	3,612	5,207,000	300	1,038
1915..........................	4,634	6,429,794	256	1,634
1916..........................	3,553	5,234,620	....	1,627
1917..........................	3,086	3,474,613	....	1,809

Schedule.—Payment is made for 98 per cent. of the silver content of the ore determined by commercial assay, on the following terms and conditions:

Treatment charge, $25 a ton of ore.

Refining charge, 0.75 cent per ounce of silver content on ore assaying 3,000 ounces and over per ton; one cent per ounce on ore assaying 2,000 to 3,000 ounces per ton; one and one-half cents per ounce on ore assaying less than 2,000 ounces per ton.

Terms of payment, 75 per cent. of net proceeds 30 days after completion of sampling. All ore is to be delivered in carload lots f.o.b. Marmora station, and to be at the shipper's risk until sampling is undertaken.

Canadian Copper Company

The cobalt plant of the Canadian Copper Company was situated at Copper Cliff, about one-quarter of a mile south of the large copper-nickel smelter of the same company.[1]

The works were designed to smelt and treat ores and concentrates from the Cobalt silver mines, and were in operation from 1905 to 1913. This plant was closed because of the extended treatment of the ores in cyanide plants at the mines. The following is an outline of the method used:

Treatment.—The ore was crushed, ground in a ball-mill to 30-mesh, and from the ground ore, one-tenth was removed by a Snyder sampler. Sampling was completed by coning and quartering. The first quartering divided the sample into two parts, which were treated as two independent samples. The ore was charged with suitable fluxes into a 30 by 72-inch blast furnace, having a capacity of 25 to 30 tons per 24 hours. Limestone from Michigan was used as a basic flux, and low-grade cobalt ore as an acid flux when required.

The products of the blast furnaces were: silver, speiss, slag, and flue dust containing fine ore, coke, and crude arsenic oxide.

The silver and speiss were tapped from the furnace through the lower tap-hole and allowed to settle in a slag pot, the silver going to the bottom.

The silver button, assaying 850 parts fine, and weighing about 50 to 75 pounds, represented an extraction of about 75 per cent. of the silver in the ore. The grade of the silver was raised to 980 parts fine in an oil-fired refining furnace which had a capacity of 30,000 ounces. It was shipped in bars to the Balbach Smelting and Refining Company, Newark, N.J., for further refining. The slag from the refining furnace was returned to the blast furnace.

An average analysis of the speiss produced is as follows: silver 900 oz. per ton, arsenic, 24 to 30 per cent., cobalt 27, nickel 9 to 15, iron 20, copper 2, and sulphur 6.

Previous to 1909 the blast furnace speiss was ground and roasted to remove most of the arsenic. The roasted speiss was mixed with sodium carbonate and nitre and again heated. By this treatment the arsenic was changed to soluble sodium arsenate, the cobalt and nickel to oxides. After removing the soluble arsenate, the residue, termed leached speiss, containing 2 to 3 per cent. arsenic and considerable

[1] Bridges, The Metallurgy of Canadian Cobalt Ores. *Can. Min. Jour.*, Vol. XXXVII, 1916, pp. 48, 68, 134.

silver, was shipped to New Jersey to be refined. The above method of treatment was changed about 1909 in order to recover more of the silver, the new process being as follows:

The speiss was ground to 30-mesh, mixed with 20 per cent. salt, and roasted in mechanically rabbled Edwards furnaces, fitted with water-cooled rabbles. Each furnace had a capacity of 2,400 pounds per 24 hours. The chloridized speiss was then treated with water to dissolve the soluble cobalt, nickel, and copper salts. The solution was passed through a tank containing scrap iron, which precipitated the copper, after which the cobalt and nickel were precipitated as hydroxides by caustic soda, converted into oxides in an oil-fired furnace, ground in a pebble-mill, and barrelled for shipment. An approximate assay of this material is as follows: silver 15 oz. per ton, arsenic 0.3, cobalt 40, and nickel 3 per cent. The small amount of nickel in the foregoing analysis in proportion to the cobalt is due to the nickel chloride being more readily decomposed than the cobalt chloride. The treatment of the speiss was continued with four covers of hyposulphite of soda solution, the residue finally containing 20 to 30 oz. of silver per ton. The silver was precipitated as sulphide by the addition of a saturated solution of sodium sulphide, filtered in a filter-press, dried, mixed with 100 per cent. sodium nitrate and 10 per cent. sodium carbonate, heated to redness in an oil-fired roasting furnace, and then transferred to tanks where it was leached with hot water. A spongy mass of metallic silver remained, with a small quantity of cobalt and nickel. The spongy mass, which contained from 60 to 65 per cent. of silver, was added to the bath in the silver-refining furnace.

The residues from the first hyposulphite leaching were mixed with quartz and smelted in a blast furnace to remove the iron. The resultant products were slag, speiss, and flue dust.

The slag, which contained 15 ounces silver per ton, 10 per cent. cobalt, and less than 1 per cent. nickel, was smelted with other high-silver slags, and pyrite from Capelton, Quebec.

The speiss from this second smelting had the following approximate composition: silver 300 ounces per ton, arsenic 25 to 30 per cent., cobalt 35, nickel 25, iron 3.5, and copper 2 per cent., also a little sulphur when the arsenic was low.

The second speiss was treated similarly to the first up to the time when the first residue was removed from the cylinders after treatment with hyposulphite. The second speiss residue, which contained 20 per cent. arsenic, was mixed with 20 per cent. sodium nitrate and 10 per cent. sodium carbonate, and roasted in a hand-rabbled reverberatory furnace. This treatment changed the arsenic to sodium arsenate, which was dissolved in hot water, the solution being discarded. The residue, after drying, had the following approximate composition: silver 20 to 30 oz. per ton, arsenic 0.3 to 0.7 per cent., cobalt 35 to 37, nickel 23 to 25, copper 3, and iron 5 per cent.

Payment was received for the silver in the residues, as well as for the cobalt and nickel oxides.

The arsenious oxide from the blast furnace and roasting furnaces was collected in flues and charged into an arsenic refining furnace. The residue, a clinker high

in silver, was returned to the blast furnace. The final product was refined white arsenic which contained 99.98 per cent. arsenious oxide (As_2O_3) and 0.3 ounces of silver per ton.

The slag from the blast furnace was rejected except when it assayed more than 10 ounces of silver per ton, in which case it was retreated in the blast furnace.

The 200 to 300 horse-power required was supplied from the company's plant at High Falls, 14 miles from the smelter.

The following table shows the ore treated and the production of the cobalt plant of the Canadian Copper Company from the commencement of operations to their close in 1913.

Year	Ore Treated Lbs.	Silver, Fine Ozs.	Metallic[1]		White Arsenic lbs.
			Cobalt lbs.	Nickel lbs.	
1906	1,767,692.5	1,282,692.78	9,021	3,987	....
1907	4,560,627.5	3,829,542.82	331,151	138,427	510,622
1908	9,857,072.5	8,551,582.07	464,171	268,140	942,827
1909	10,651,189.5	8,779,014.55	690,737	463,588	1,242,722
1910	9,792,511.0	8,696,624.87	346,483	260,756	843,619
1911	6,744,108.0	6,584,102.46	238,684	234,323	680,074
1912	3,667,301.0	3,523,207.80	223,163	209,330	476,156
1913	186,602.0	47,590.00	15,506	7,161	95,669
Total	47,227,104.0	41,294,357.35	2,318,916	1,585,712	4,791,689

Canada Refining and Smelting Company Limited

The plant of the Canada Refining and Smelting Company Limited,[2] was situated in the southern part of the town of Orillia, Ontario, and adjacent to the Grand Trunk, Canadian Pacific, and Canadian Northern railways.

Construction was started early in September, 1910, and smelting was commenced in February, 1911.

The plant was designed for the treatment of silver ores from Cobalt, and had a capacity of about 13 tons daily. It produced refined silver, white arsenic, and mixed oxides of cobalt and nickel.

This plant has not been operated since early in 1913, but the treatment of the ore was as follows:

The crushing and sampling was done at Cobalt by Campbell and Deyell, samplers and assayers, before shipment to the smelter. The ore was smelted in a 48-inch circular shaft furnace, which produced silver, argentiferous speiss, slag, and flue dust.

The silver recovered from the furnace assayed 900 parts fine and represented an extraction of 80 per cent. It was refined to 996 parts fine in a cupellation furnace of a capacity of 10,000 ounces. The slag from the refining furnace

[1] These figures represent the metallic nickel and cobalt contained in the crude oxides in which form they were shipped.

[2] Cole, Arthur A., Report of the Temiskaming and Northern Ontario Railway Commission, Toronto, Canada, p. 68, 1913.

reverted to the blast furnace. Limestone and iron ore were used as fluxes when required, the limestone being obtained from Longford quarry, nine miles distant from the smelter, and the iron ore brought from Midland, Ontario.

The speiss was ground, roasted and re-ground. It was treated with chemicals, when most of the metals except the silver were dissolved. The impure silver-bearing residue was separated from the liquor in filter-presses and recharged into the cupola furnace.

The iron, arsenic, and copper were first precipitated from the liquor, and finally the cobalt and nickel precipitated together as carbonates. The mixed carbonates were heated in a hearth furnace and converted to oxides which, after being ground, were barrelled and shipped. The oxides assayed 40 per cent. of cobalt and 25 per cent. of nickel.

The flue dust was treated to recover pure arsenious oxide.

About 300 horse-power was required by the plant. This was supplied by the town of Orillia, from a hydro-electric installation 18 miles distant from the town, at the rate of $18.40 for 24-hour service per horse-power year. About 80 men were employed.

Metals Chemical, Limited

During 1915 Metals Chemical Limited, Welland, Ontario, erected a plant to treat low-grade Cobalt ores and residues. The ores are smelted in a blast furnace, with a capacity of 30 tons of ore per day. The products of the furnace are silver, speiss and slag. The speiss is roasted to remove the arsenic and the roasted product treated with chemicals to dissolve the cobalt and nickel. The following products are shipped: cobalt oxide, cobalt carbonate and sulphate, nickel oxide and sulphate, refined silver and white arsenic (As_2O_3).

The Standard Smelting and Refining Company Limited, erected during 1914, a small plant at North Bay, Ontario, to treat ores from Cobalt. This company in 1915 moved its works to Orillia, Ontario, and cobalt ores were treated during part of 1916. The company went into liquidation and the plant was taken over by the International Molybdenum Co.

Under the provisions of the "Metal Refining Bounty Act," passed by the Ontario Legislature in 1907, there was paid a bounty of six cents a pound on the metallic contents of cobalt and nickel oxides produced within the Province. The total bounties to be paid in any one year were not to exceed the sum of $30,000 for cobalt and $60,000 for nickel. This Act expired in April, 1917. The table given below shows the total amount paid in bounties.

Summary of Bounties Paid

Company	Cobalt	Nickel	Total
	$ c.	$ c.	$ c.
Deloro Smelting and Refining Co., Ltd.	48,930 93	8,166 96	57,097 89
Coniagas Reduction Co., Ltd.	67,174 99	27,539 01	94,714 01
Metals Chemical Ltd.	9,577 60	6,766 04	16,343 65
Canadian Smelting and Refining Co., Ltd.	1,026 05	681 84	1,707 89
Standard Smelting and Refining Co., Ltd.	214 92	....	214 92
Dominion Refineries Limited	62 59	....	62 59
Total	126,987 08	43,153 85	170,140 95

Previous to 1913 a large amount of cobalt ore had beeen shipped to the United States to be refined, as there was an import duty of 25 cents per pound on refined cobalt oxide. However, in 1913 the charges on cobalt products entering the United States were changed and at present are as follows:

Product.	Old Tariff	New Tariff
Cobalt oxide	25 cents per lb.	10 cents per lb.
Cobalt metal	free	free
Cobalt ore	free	free
Cobalt alloy steel	0.2 to 7 cents per lb. according to the value and 20 per cent. above 40 cents per lb.	15 per cent. ad. val.

A synopsis follows of the methods employed in Europe for the production of cobalt oxide, and of the numerous processes which have been proposed, many of which have never been put to the test of actual practice.

Herrenschmidt and Constable Processes[1]

These processes were used chiefly on the ores from New Caledonia and Australia.

Process No. 1.—The cobalt ore was smelted with argentiferous lead or copper sulphides in a blast furnace, the products being a matte containing the cobalt, nickel, copper, or lead as sulphides, and a silicate slag containing the iron and manganese. The matte was ground and heated to convert the sulphides of the metals into soluble sulphates, the lead sulphide, however, forming an insoluble sulphate. The sulphate solution was then treated by one of the following methods:

(*a*) The copper in the solution was precipitated by iron, the solution filtered upon a layer of New Caledonia mineral, the iron in solution precipitating, and a corresponding amount of cobalt, nickel, and manganese dissolving. Magnesia (MgO) was added next to precipitate the nickel, cobalt, and manganese. The precipitate was treated with a fresh quantity of solution containing cobalt, nickel, and manganese sulphates, by which treatment the manganese hydroxide dissolved, while a corresponding quantity of cobalt and nickel hydroxides was precipitated.

(*b*) To the sulphate solution, calcium chloride was added to change the sulphates into chlorides. The solution was filtered to remove the calcium sulphate and any insoluble matter, and then treated with lime, the iron and part of the copper being precipitated as hydroxides. The last of the copper was precipitated with nickel hydrate or carbonate. The solution was then treated with calcium or sodium carbonate which precipitated the cobalt, nickel, and copper. The precipitate of mixed carbonates or hydrates was redissolved, and the solution treated to remove the copper as above, so that only cobalt and nickel remained in solution.

Process No. 2.—The ore was treated with hydrochloric acid, and the solution of chlorides was reduced by filtering on scrap iron. The solution of ferrous chloride obtained was used to attack fresh quantities of New Caledonia ore. The acid treatment was applied chiefly to the cobalt ores from Australia.

[1] Wagner's Jahresbericht, Vol. XXX, 1884; pp. 152, 396; Vol. XXXII, 1886, pp. 157-158; Vol. XXXVIII, 1892, p. 208; Jour. Soc. Chem. Ind., Vol. XI, 1892, p. 167; Schnabel, Handbook of Metallurgy, Vol. II, 1898, p. 603.

At the plant of the Malètra Co., Rouen, France, the pulverized ore from New Caledonia was treated with a ferrous sulphate solution and steam. The solution after such treatment contained the sulphates of cobalt, nickel, and manganese, the iron forming a basic sulphate precipitate. The iron precipitate, silica, and alumina were removed by filtering and washed in a filter press. To the sulphate solution sodium sulphide was added, which precipitated the sulphides of cobalt and nickel, as well as a small quantity of manganese.

The precipitate was filtered in a filter press, and, after washing, was digested with a calculated quantity of ferric chloride, which dissolved only the manganese sulphide. A black precipitate of cobalt and nickel sulphides remained, the solution containing the sulphates and chlorides of manganese and iron. The sulphide precipitate was dried, ground, and heated to form sulphates. The mixture of sulphates was dissolved in water and treated with a solution of calcium chloride, the calcium sulphate formed being removed. The solution was divided into two parts, A and B. To the first portion of solution A milk of lime was added to precipitate the cobalt and nickel; afterwards the precipitate was washed in a filter press to remove any excess of calcium chloride. The washed precipitate was digested with water and oxidized by chlorine mixed with air. A part of solution B containing cobalt and nickel chlorides was added to the hydroxides obtained from solution A, and the mixture agitated. By this treatment the nickel hydroxide was reduced by the cobalt chloride of solution B and dissolved, a corresponding quantity of cobalt precipitating, according to the following reaction.

$$Co_2O_3+Ni_2O_3+2CoCl_2=2NiCl_2+2Co_2O_3.$$

Another method of treating the ores from New Caledonia was to make a matte which was afterwards ground and heated to form sulphates. The sulphates were dissolved, and the iron was precipitated by careful additions of sodium carbonate. The copper was precipitated by hydrogen sulphide, and after boiling off the excess, the cobalt was precipitated by sodium hypochlorite. Bleaching powder cannot be used owing to the sulphates in solution. The nickel was precipitated from the remaining solution by sodium carbonate. Also metallic copper was precipitated from copper-cobalt-nickel-iron solutions by the addition of matte. The iron was precipitated by adding a salt of nickel or cobalt.

Borchers and Warlimont[1] proposed treating minerals containing sulphides of nickel, cobalt, copper, and iron by a partial roast at 500° C. In this treatment the cobalt and copper were changed almost completely to sulphates, the nickel remained partly as sulphide and partly as oxide, the iron as oxide and ferrous and ferric sulphates. The furnace product was treated with water for several days, when any copper sulphide remaining in the ore reacted with the ferric sulphate, forming copper sulphate and ferrous sulphate. This was followed by a treatment with a slightly acidulated solution which dissolved the sulphates of cobalt and copper and at the same time a small quantity of nickel and a little iron sulphate. The residue was treated to recover the nickel. The copper was removed from the cobalt solution by scrap iron, and calcium sulphide was added to precipitate the nickel and cobalt as sulphides.

[1] Eug. Prost, Cours de Métallurgie des Metaux autres que le Fer, 1912, p. 663, Ch. Béranger, Editeur, Paris.

Lundborg[1] describes the treatment of ores containing earthy cobalt formerly used at the Editha Smalt Works in Silesia. The ores were agitated with concentrated hydrochloric acid in clay vessels to dissolve the cobalt, some nickel and iron dissolving at the same time. The iron was precipitated from the solution by adding small quantities of marble. As soon as nickel began to be precipitated the separation of iron was known to be complete. To the filtrate soda was added to precipitate the nickel. When cobalt began to come down, the liquid was filtered, and the precipitation continued, a mixture of the two hydroxides forming until all the nickel had been precipitated. Cobalt hydroxide was precipitated from the final filtrate. The precipitate of mixed oxides was redissolved, and the two separated by fractional precipitation.

The matte, from the Sesia Works at Oberschlema, in Saxony, was similarly treated. It contained Ni 16, Co 14, Cu 50, and S 20 per cent. The powdered matte was roasted in a reverberatory furnace and treated with dilute sulphuric acid. The copper was precipitated by iron, after which the rest of the process was the same as that described above.

At Schladming, Styria,[2] ore containing 11 per cent. of nickel and 1 per cent. of cobalt was roasted in stalls and afterwards smelted in blast furnaces. The charge consisted of 89 parts of roasted ore, and 19 parts of quartz. In 24 hours five tons of ore were treated, using 1,800 pounds of wood charcoal. The speiss, which was tapped every two hours, contained Ni 45 to 47, Co 4 to 6, Fe 8 to 10, Cu 1 to 1.5, As 33 to 36, S 1 to 2, and carbon 1 to 2 per cent.

At the George Works at Dobschau, Hungary,[3] about 1876, ore containing nickel 4.5 and cobalt 1.5 per cent. was roasted in stalls, and then smelted in circular blast furnaces 16.5 feet high, with two tuyeres. The diameter of the furnace was 3 feet 4 inches at the level of the tuyere, and 4 feet at the mouth. The tuyeres were 2.75 inches in diameter, and the blast pressure equal to 2.5 inches of mercury. The charge consisted of 100 parts of ore, 3 to 4 quartz, 8 to 12 limestone, and 5 to 10 rich slag. The capacity of the furnace was 7 to 10 tons of ore per 24 hours, using 20 per cent. charcoal. The speiss contained from 16 to 20 per cent. of nickel and cobalt. This was roasted in stalls, and then smelted to form a concentrated speiss in a blast furnace similar to that used for the ore. The capacity of the furnace was about 11 tons per 24 hours. To the charge of roasted speiss, about 2.5 tons of quartz were added to flux the iron oxide formed during the smelting operation. Charcoal was used as a fuel, the consumption being about 26 per cent. of the weight of the charge. The concentrated speiss contained Ni and Co 31.9, Cu 1.9, Fe 26.4, As 36.3, and S 3.1 per cent.

The concentrated speiss was roasted and charged into a small blast furnace similar to that used for the ore. The capacity of the furnace was about two tons of roasted speiss. After the charge (100 parts of roasted speiss, 4 parts of quartz, 2 parts of glass and 1 part of soda), had melted, a strong air-blast was turned on, by which the iron was oxidized first. The iron oxide was slagged by addition of quartz, glass, and soda. To prevent large quantities of cobalt being slagged, the

[2] Schnabel, Handbook of Metallurgy, Vol. II, 1898, p. 602.
[2] Schnabel, Vol. II, p. 562.
[3] Schnabel, pp. 562, 586.

iron was not completely oxidized, 8 to 10 per cent. remaining in the speiss. The speiss formed by this operation was called doubly concentrated speiss and contained Ni and Co 50 to 52, Cu 1 to 2, Fe 8 to 10, As 38 to 40, and S 1 to 2 per cent. The slag contained 1 to 2 per cent. Ni and Co, and was re-charged into the blast furnace treating the ore.

The high-grade speiss was crushed in a stamp-battery, and then roasted for 12 to 14 hours in wood-fired reverberatory furnaces with a capacity of about 600 pounds to a charge. After roasting, 65 to 90 pounds of sawdust or coal dust was added which reduced any arsenates to arsenites, from which compound the last of the arsenic may be removed. The roasted product was treated with sulphuric acid and the solution filtered. Iron and copper were precipitated by additions of calcium carbonate to the boiling solution, after which cobalt hydroxide was precipitated by calcium hypochlorite, and nickel by milk of lime. The cobalt and nickel oxides were dried, washed, ground, and sold to the colour works in Saxony.

At Saint Benoit, near Liege,[1] speiss containing 45 per cent. of nickel was treated with concentrateed hydrochloric acid at 80° C. Iron was precipitated from the solution in the usual way, and then copper by calcium sulphide. Next cobalt was precipitated by chloride of lime, and lastly nickel by milk of lime.

Dixon[2] proposed smelting garnerite, a hydrated nickel magnesium silicate of New Caledonia, with the addition of arsenical materials, to form a speiss. This was roasted, and treated with hydrochloric acid. Into the chloride solution chlorine was passed to oxidize the iron, which was afterwards precipitated by the careful addition of nickel hydroxide. Cobalt was then precipitated as hydroxide by passing more chlorine through the solution, and adding more nickel hydroxide. The solution containing the nickel chloride was evaporated. The salts obtained were heated in a furnace through which steam or hydrogen was passed, producing nickel oxide or metallic nickel respectively. A little nickel was precipitated with the cobalt, but this was removed by leaching with dilute hydrochloric acid. It is also stated that the addition of manganese dioxide to a neutral cobalt and nickel solution completely precipitated the iron, but this is questionable, if not impossible. The statement is also made that anhydrous nickel oxide was used where hydroxide is mentioned above for precipitating iron and cobalt, but knowing the solubility of nickel oxide, the writer also questions such a statement.

At a works in Birmingham, England,[3] speiss was roasted and dissolved in hydrochloric acid. Iron was first oxidized, then precipitated as arsenate and hydrate, by neutralizing the hot solution with calcium carbonate. Copper was precipitated next by sulphuretted hydrogen, then the cobalt by calcium hypochlorite (bleaching powder), and finally the nickel by milk of lime. In precipitating the cobalt a small amount of quicklime was added to neutralize any liberated acid.

A direct treatment of unroasted matte with acid was formerly in use at the Scopello works in Piedmont.[4] Nickel matte, containing Ni 24, Co 6, Cu 12, Fe 23, and S 35 per cent. was treated with hydrochloric acid (33 per cent. HCl) in stoneware vessels surrounded by water. The sulphuretted hydrogen formed was

[1] Schnabel, Vol. II, p. 586.
[2] Chemical News, Vol. XXXVIII, 1878, pp. 268-270.
[3] Phillips. Elements of Metallurgy, 1891, p. 415.
[4] Schnabel, Vol. II, p. 581.

removed by a tube in the cover of the vessel and burned. After the matte had been treated three times with acid, the liquid was removed from the residue, which consisted of the copper sulphide of the matte and an appreciable quantity of nickel and cobalt sulphides. This was charged into the blast furnace during the smelting of matte or ore. The solution, containing chlorides of iron, nickel, and cobalt, was allowed to settle, and then evaporated to dryness in a cast-iron pot. The residue, a mixture of the three chlorides, was heated in a reverberatory furnace for 3 or 4 hours, with continual rabbling, during which process part of the iron was volatilized as chloride and part changed to ferric oxide.

The furnace product was agitated with water to dissolve the soluble cobalt and nickel chlorides, any undecomposed iron chloride present dissolving at the same time. The iron chloride was oxidized with chloride of lime and precipitated with calcium carbonate. Cobalt was precipitated next by further additions of chloride of lime to the iron-free solution, and finally nickel was precipitated with milk of lime.

The precipitates of cobalt and nickel hydroxides were washed in woollen sacks to remove any soluble lime salts, until no cloudiness was visible in the water on the addition of ammonium oxalate. The oxides were given a final wash with acidulated water.

Other Proposed Processes

Beltzer[1] outlines a process for the treatment of ores from Cobalt, Canada, as follows. The ore was to be first concentrated and the silver removed by amalgamation. The concentrate, after amalgamation, is roasted (*a*) with or without additions of carbon to remove the arsenic, as oxide, or (*b*) treated with lime or soda and the arsenic removed as soluble arsenite or arsenate, or (*c*) heated with sodium bisulphate and acid (66° Bé.) to remove the last traces of arsenic. By the last method of treatment the soluble sulphates of cobalt and nickel are formed. In case of treatment (*a*) or (*b*), the roasted product is afterwards given either a chloridizing roast with salt, or heated with hydrochloric acid, or sulphuric acid and salt. In any case, after dissolving the soluble salts and filtering the solution containing chlorides of nickel, cobalt, and a small quantity of iron, the cobalt is precipitated by Rose's method (caustic soda and current of chlorine) or by hypochlorite of calcium or sodium. The precipitation of cobalt may also be completed by the following method. If the cobalt and nickel are in the form of sulphates, calcium chloride is added, which converts the sulphates into chlorides. The solution is filtered and then divided into two parts, A. and B. The cobalt and nickel in solution A are completely precipitated by milk of lime, filtered and washed. The precipitate of cobalt and nickel hydroxides is mixed with water and oxidized by a current of chlorine and air. When the solution is saturated with chlorine, a part of solution B is added and the mixed solution boiled. The nickel hydroxide is reduced by the cobalt chloride of solution B and dissolves, a corresponding quantity of cobalt precipitating. In this way practically pure cobalt hydroxide is obtained.

[1] Beltzer, The Rational and Industrial Treatment of the Complex Ores of Silver, Cobalt, Nickel and Arsenic of Cobalt, Canada. Moniteur Scientifique, Vol. XXIII, 1909, pp. 633-647.

Quantities of solution B are added until the precipitate is practically pure cobalt hydroxide.

Beltzer also outlines the following electrolytic process to separate cobalt from nickel, but the process does not appear to be practicable. To the chloride solution salt is added and the solution electrolyzed, using platinum electrodes. Nascent chlorine and sodium hydrate are formed, the caustic soda precipitating the cobalt, the nickel remaining in solution.

A solution containing sulphates of cobalt, nickel, and a small quantity of iron may be treated by the following method. The iron is precipitated by milk of lime or nickel hydrate, a corresponding quantity of lime or nickel going into solution. Soda is added to precipitate the cobalt and nickel which are separated by additions of chlorine to a neutral solution. In the oxidation with chlorine, nickel dissolves, and at the same time a corresponding quantity of cobalt is precipitated so that the original rose colour, due to the cobalt, changes to a green. To be certain that the cobalt hydrate precipitate does not contain nickel, it is necessary to leave a little cobalt in solution.

Another process[1] consisted in mixing cobalt-silver ore with a lead furnace-charge and smelting. The lead collected the silver, and the cobalt and nickel formed a speiss. The speiss was roasted with carbon to remove arsenic, the cobalt combining with silica, which was added as silicate. The cobalt silicate was treated with hydrochloric acid, and the cobalt and nickel hydroxides were precipitated by lime water.

It does not appear to the author that the processes to treat cobalt ores, as outlined on the following pages, with perhaps a few exceptions, are anything more than laboratory experiments or ideas. As mentioned in the introduction, a summary of each is given merely to record all attempts that have been proposed to treat cobalt ores.

Readman[2] proposed mixing the ground ore with sodium sulphate in sulphuric acid, in the proportions of 100: 84: 65. The mixture was heated to a red heat, the cobalt, nickel, and manganese forming soluble sulphates. After dissolving the sulphates, the solution was neutralized with calcium carbonate and heated, the iron precipitating. The sulphate solution of cobalt, nickel, and manganese was treated with sodium sulphide to precipitate only the cobalt and nickel. In another process the use of ferric chloride was suggested. After treating the ore, the product was heated to render the iron insoluble. The cobalt and nickel were dissolved from the roasted mass.

Gauthier[3] used iron pyrites and gypsum to decompose cobalt ore, obtaining sulphates of cobalt and nickel.

Stahl[4] proposed roasting the mineral, then mixing it with salt and sulphide of iron. The copper, cobalt, and nickel were changed to soluble chlorides, the iron and manganese to insoluble oxides. The chloride solution was treated with

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[1] Ouvrard, Industries du Chrome, du Manganese, du Nickel, et du Cobalt, p. 258, Doin and Sons, Paris, 1910.

[2] Ouvrard, p. 262; Jour. Soc. Chem. Ind., Vol. III, 1884, p. 524.

[3] Wagner, Jahresbericht, Vol. XXXII, 1886, p. 157.

[4] German Patent, No. 58,417, 1890. Wagner, Jahresbericht, Vol. XXXVII, 1891, p. 210, Ouvrard, pp. 265-266. Schnabel, Vol. 2, p. 605.

hydrogen sulphide to precipitate the copper, and after neutralization with soda, cobalt and nickel were precipitated by sodium sulphide along with any iron, manganese, and copper. The mixed sulphides were treated with dilute acid to dissolve any iron, manganese, or copper sulphides. The cobalt and nickel sulphides were roasted to sulphates and separated by one of the previously mentioned methods.

In the Natusch or Schoneis process[1] the roasted mineral was heated with ferric chloride. The chloride solution was treated with calcium sulphide, which precipitated the cobalt and nickel and a small quantity of manganese as sulphides.

Precourt and Falliet[2] suggested roasting cobalt ore with iron sulphide, FeS_2, the cobalt, nickel, and manganese being changed to soluble sulphates, most of the iron forming oxide. The iron was precipitated from the solution with calcium carbonate and removed. The sulphates of cobalt, nickel, and manganese were changed to chlorides by the addition of calcium chloride, calcium sulphate being precipitated and removed. Nickel and cobalt were precipitated with calcium sulphide, the manganese remaining in solution. The sulphides of nickel and cobalt were washed with dilute sulphuric acid to remove any manganese sulphide, and afterwards heated to form sulphates. To the filtered solution of the sulphates, hypochlorite was added. After making the solution alkaline it was made faintly acid, the cobalt precipitating as sesquioxide, the nickel remaining in solution.

Dyckerhoff[3] proposed decomposing ore containing silver, cobalt, nickel, and arsenic by roasting the ore with salt, clay, and pyrites, by which treatment the silver, cobalt, nickel, and arsenic were converted to chlorides. The insoluble silver chloride was removed, while the arsenic chloride was volatilized or changed to the volatile oxide. The cobalt and nickel remained as soluble chlorides.

In the Warren process,[4] cobalt ore was treated with hydrochloric acid and copper nitrate, the metals passing into solution. Milk of lime was added, which precipitated the iron as hydroxide and arsenate. Lime was removed by the addition of sulphuric acid, and afterwards the cobalt and nickel were precipitated as carbonates by soda. The solution was filtered, diluted, and chlorine gas passed through until the solution was saturated, after which it was boiled, the nickel hydroxide dissolving and cobalt hydroxide remaining. The solution was filtered and the nickel precipitated by caustic soda.

Gauthier[5] heated ground cobalt ore with hydrochloric and sulphuric acids and completed the process by the usual methods.

Carnott[6] heated the ore to render any iron insoluble, and then treated the product with hydrochloric acid and neutralized the solution with calcium carbonate to precipitate the iron. The filtered solution was treated with milk of lime, which precipitated first the cobalt, then the nickel, and finally the manganese. The fractional precipitation of the cobalt, nickel, and manganese was not satisfactory.

[1] Ouvrard, p. 264. Schoneis, Berg. u hüttenm. Zeitung, 1890, p. 453. Wagner, Jahresbericht, Vol. XXXVI, 1890, p. 338. Chemiker Zeitung, Vol. XIV, 1890, p. 770, p. 1475.
[2] French Patent 403,830, June 9, 1909. Jour. Soc. Chem. Ind., Vol. XXIX, 1910, p. 97.
[3] United States Patent. No. 1,085,675, Feb. 3, 1914.
[4] Chemical News, Vol. LVI, 1887, p. 193.
[5] Gauthier, Wagner Jahresbericht, Vol. XXXII, 1886, p. 157.
[6] Ouvrard, p. 258.

Clark[1] treated the ground mineral with a boiling solution of ferric chloride. The solution was evaporated to dryness and the residue calcined at 350° to 370° C. Cobalt, nickel, and manganese were changed to chlorides by the decomposition of the ferric chloride which formed ferric oxide. Cobalt and nickel sulphides were separated from manganese by precipitation with calcium sulphide. This method was tried at Glasgow, Scotland.

Dickson and Ratte[2] dissolved the cobalt, nickel, and manganese of a cobalt mineral by treatment with sulphurous acid, alone, or mixed with other acids. The iron oxide remained insoluble. The finely-ground cobalt mineral was mixed with water at 50° C. in vats provided with stirring arrangements, and the sulphurous acid introduced. The mixture was transferred to a second vat, where the iron oxide and the impurities settled. The solution was filtered through a bed of pulverized mineral, which retained the suspended impurities and neutralized the excess acid, while the last traces of iron were precipitated. From this solution the cobalt and nickel were precipitated as sulphides by sodium sulphide and afterwards separated.

Cobaltite was ground and carefully roasted with additions of small quantities of carbon.[3] The residue was treated with sulphuric acid. From the solution obtained the iron was precipitated with calcium carbonate, and other metals with hydrogen sulphide. The solution was filtered and treated to recover the cobalt and nickel.

Barth[4] gives some experimental results obtained in working on a method to treat a roasted speiss containing lead, cobalt, nickel, iron, and manganese. Decomposition by acids, chlorine, chloridizing roasting, and by sulphur dioxide was tried.

Phillips[5] outlines a process for smelting cobalt silver ores using sufficient iron matte and copper residue to form a speiss, an argentiferous copper matte, and a slag. The operation was repeated to obtain speiss free from silver and copper.

De Burlet[6] proposed extracting cobalt from cobalt and nickel silicate minerals and slags from copper smelting by treating them with dilute sulphuric acid, and after decomposition the mass was heated to 150°-200° C. to render the silica insoluble. The soluble salts were dissolved in hot water, the solution filtered, and calcium carbonate added to precipitate the iron and the greater part of the copper. The remaining copper was removed by electrolysis, and then the solution was treated with ammonia to obtain cobalt and nickel compounds. The ammoniacal solution was electrolyzed, using carbon or lead anodes and polished nickel-plated iron plates as cathodes. The surfaces of the cathodes were coated with paraffin to prevent the metal adhering. The metal fell to the bottom of the tank in thin flakes.

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[1] Ouvrard, p. 263.
[2] French Patent, Sept. 5th, 1885.
[3] Ouvrard, p. 258.
[4] Barth, Treatment of a Roasted Lead-Cobalt-Nickel Speiss, Metallurgie, Vol. IX, 1912, p. 199. Chem. Abst., Vol. VI, 1912, p. 1732. Jour. Soc. Chem. Ind., Vol. XXXI, 1912, p. 391.
[5] United States Patent, 1,127,506, 1915.
[6] British Patent, 27,150, Nov. 25, 1913.

Cito,[1] after experimenting with other processes, patented the following treatment for ores from Cobalt, Canada. The raw ore was treated in a reverberatory furnace with copper and fluxes. Two products were obtained, viz., an alloy containing the copper and all the silver, nickel, cobalt, and arsenic; and a slag. The alloy was cast from the furnace into anode moulds. The metals were recovered by electrolysis, using an electrolyte of copper sulphate, and sheet copper cathodes. The copper was deposited on the cathodes in a pure form, the silver precipitated as slime, and the cobalt and nickel remained in solution. The arsenic was found partly in solution and partly as slime.

From the electrolyte containing copper, cobalt, nickel, and arsenic, copper was precipitated in the cold solution, and arsenic later in the hot solution, by hydrogen sulphide. The cobalt nickel solution was treated to recover the cobalt and nickel by the ordinary processes.

Andre[2] attempted to recover cobalt and nickel from a cobalt-nickel matte as an anode and using an electrolyte of dilute sulphuric acid or ammoniacal cobalt sulphate. A frame containing granulated metal was placed between the anode and cathode and on this copper and silver were precipitated.

Vortmann[3] proposed a process to obtain by electrolysis cobaltic oxide or hydrate from solutions containing cobalt and nickel. This process was based on the assumption that if a current is passed through solutions of cobalt and nickel containing no alkaline sulphates or other neutral salts of the alkalies, cobaltous and nickelous hydrates or basic salts of both form at the cathode. If the current is reversed the nickelous hydrate or corresponding basic salt dissolves, while cobaltous hydrate is oxidized to cobaltic hydrate. On changing the current to its original direction more of each lower hydrate is produced, and on again reversing the current the nickel is dissolved. In this way all the cobalt is finally precipitated as hydrate, and all the nickel remains in solution. If there is a small quantity of a chloride present in the liquid (equivalent to 1 per cent. of common salt), the cobaltous hydrate is very quickly oxidized to the higher compound by the small amount of chlorine or hypochlorous acid set free. In this case the constant change of current is unnecessary.

The separation of cobalt is assisted by gentle warming. After the precipitation is completed, the current is stopped and the liquid heated to 60° or 70° C. whereby any small quantity of nickelic hydrate remaining in the cobalt compound is dissolved. The nickel solution when filtered does not contain any cobalt.

Guiterman[4] has patented a process to extract cobalt oxide by electrolyzing a nickel and cobalt solution containing chlorides. The chlorine liberated at the anode reacts with the electrolyte to form hypochlorite, the hypochlorite reacting with the cobalt in solution to form hydrated oxide of cobalt and some free hydrochloric or sulphuric acids. To prevent the electrolyte becoming too acid, in which case the cobalt hydrate would redissolve, sodium carbonate solution is added.

[1] Cito, Trans. Amer. Electrochemical Soc., Vol. 17, 1910, p. 239.
[2] Ouvrard, p. 265
[3] German Patent, No. 78,236, May 10, 1894, Schnabel, Vol. II, p. 608.
[4] United States Patent 1,195,211, August 22nd, 1916.

The firm of Basse and Selve, Altena, Germany, have suggested a process[1] which consists first in adding certain organic salts to neutral or slightly acid solutions containing nickel, cobalt, iron and zinc, such as will prevent the precipitation of their oxides by alkalies. Such are acetic acid, citric acid, glycerine, and dextrose. The solution is made alkaline by soda or potash lye, and subjected to electrolysis with a current of 2.8 to 9.3 amperes per square foot. Iron, cobalt and zinc are deposited on the cathode, while nickel either remains entirely in the liquid or precipitates partly as hydrate, according to the alkalinity of the solution. The precipitation of the hydrate occurs if the current is continued for a long time. To the nickel solution free from other metals, ammonium carbonate is added to form carbonate of all the free alkali, after which it is electrolyzed. Nickel is formed as a bright deposit on the cathode.

Coppet[2] smelted ore to obtain a matte, which was ground and roasted to form oxides of copper, nickel, and cobalt. The oxides were reduced to the metallic state, then treated with a solution of a cupric salt. The copper was precipitated afterwards by metallic cobalt and nickel. No further explanation is given of this process. In another process the same author roasted matte to form sulphates or chlorides by the addition of salt. Copper was removed as above.

To treat nickel ores or products containing cobalt, the following methods have also been suggested. The complete treatment is not given in all cases but only those parts which differ from other processes.

Laugier[3] dissolved the ore in nitric acid, and evaporated the solution, the arsenic being precipitated as oxide during the evaporation or later by hydrogen sulphide. The solution was filtered, and heated till the excess of sulphuretted hydrogen was expelled, then the iron was oxidized. Sodium carbonate was added in excess, while the liquor was hot, to precipitate the nickel and cobalt in the form of carbonates, and the iron as hydrate. The precipitate was then washed and digested with an excess of oxalic acid solution, the soluble ferric oxalate being separated by filtration from the oxalates of nickel and cobalt which are insoluble even in excess of oxalic acid. The latter salts were mixed with dilute ammonia in a closed vessel. (Stromeyer[4] recommends strong ammonia), to dissolve the oxalates. The filtered solution, after exposure to the air for several days, deposited nickel ammonium oxalate and manganese oxalate, while the pure oxalate of cobalt remained in solution. The oxalate of nickel separated as above can be freed from the small quantity of the cobalt salt which precipitates with it, by re-treatment with ammonia. The residue, obtained by evaporating the ammoniacal solution of the cobalt oxalate, yielded sesquioxide of cobalt when ignited in the air, or metallic cobalt when ignited out of contact with the air.

Guesneville[5] treated cobalt ore with nitric acid, the iron and arsenic being removed as ferric arsenate by the addition of potassium carbonate. The cobalt was precipitated as oxalate by potassium acid oxalate.

[1] Schnabel, p. 591.
[2] Ouvrard, p. 261. Jour. Soc. Chem. Ind., Vol. XII, 1893, p. 274.
[3] Laugier, Annales de Chemie et de Physique, Paris, Vol. IX, 1818, p. 698.
[4] Stromeyer, Jour pract. Chemie, Vol. LXVII, 1856, p. 185.
[5] Guesneville, Gmelin Kraut, Handbuch der anorganischen Chemie, Band 5, 1, 1909, p. 192.

De Witt[1] treated speiss with aqua regia and removed the excess acid. Ammonium chloride and ammonia were then added, followed by additions of potassium acid oxalate. The cobalt was recovered as oxalate.

Loujet[2] dissolved cobalt ore with hydrochloric acid, and to the solution a ferric salt was added, followed by additions of potassium carbonate, calcium carbonate, or calcium hydroxide. The iron and arsenic were precipitated as an insoluble ferric arsenate.

Wöhler[3] fused cobalt speiss with potassium carbonate and sulphur in the ratio 1: 3: 3. Most of the metals were converted into simple sulphides, but the arsenic sulphide formed a soluble potassium sulphoarsenate. The temperature had to be regulated so that the cobalt sulphide did not fuse, since it would enclose portions of the soluble sulphoarsenate.

Hermkstädt[4] fused cobalt glanco with potassium nitrate, and the arsenic was removed as potassium arsenate.

Patera[5] roasted ore with additions of carbon, then fused the product with calcium nitrate, soda, and potassium nitrate. Arsenic was removed as soluble arsenates of calcium, soda, and potassium. Nickel was precipitated from the solution by potassium or ammonium bisulphate as a difficultly-soluble complex salt containing only a small quantity of the cobalt compound.

Liebig[6] roasted the ore, then mixed it with ferrous sulphate and potassium bisulphate, and fused the mixture. The arsenic was removed as insoluble ferric arsenate. Ferrous sulphate was added before fusion to prevent the formation of cobalt arsenate. During the final stages of the fusion, the nickel sulphate was decomposed, forming oxide which did not dissolve with the cobalt. Cobalt carbonate was afterwards precipitated by the addition of potassium carbonate.

Barton and McGhie[7] suggested fusing arsenical minerals with sufficient sodium carbonate to combine with the arsenic to form soluble sodium arsenate.

McKenna[8] fused cobalt and nickel speiss with boric acid about equal in weight to the cobalt in the speiss. The heavier speiss separates from the lighter cobalt borate slag.

To separate cobalt from nickel, iron and manganese, the following processes have been suggested:

Sack,[9] by the addition of lead peroxide to a solution of cobalt, manganese, aluminum, and iron salts, precipitated hydrates of manganese and aluminum, basic ferric-sulphate and lead sulphate, practically all the cobalt remaining in solution. Any copper was first removed, and then the solution was mixed with a calculated amount of peroxide of lead. In case iron was present in large quantities, it was

[1] Jour. prakt. Chemie, Leipzig, Vol. 71, 1857, p. 239.
[2] Loujet, Monit. Indust., 1849, p. 1309. Jour. Soc. Chem. Ind., Vol. 1, 1882, pp. 258-259.
[3] Wöhler, Annalen der Physik and Chemie, Vol. VI, 1826, p. 227.
[4] Hermkstädt, Jour. für Chemie und Physik, Vol. XXXI, 1821, p. 105.
[5] Patera, Jour. prakt. Chemie, Vol. XVIII, 1830, p. 164.
[6] Liebig, Annalen der Physik und Chemie, Vol. XVIII, 1830, p. 164.
[7] French Patent, No. 387,766, Jan. 28th, 1908.
[8] United States Patent No. 1,166,067, Dec. 28th, 1915.
[9] Sack, German Patent No. 72,579, 1892.

precipitated after the copper with an alkaline or alkaline-earth carbonate. If a large amount of manganese was present, it was removed by fractional precipitation with a soluble alkaline or alkaline-earth sulphide.

Iron was precipitated from a cobalt nickel solution by additions of cobalt hydrate.[1]

To a solution containing cobalt, nickel and iron, soda was added which precipitated the iron, then ammonium chloride was added followed by potassium hydrate, and the mixture heated. Nickel hydroxide was precipitated, the precipitation of cobalt hydroxide being proportional to the decomposition of the ammonium chloride.[2]

Solutions containing cobalt, nickel, iron and manganese were treated with sodium acetate and heated, the iron being precipitated. Cobalt was precipitated from the neutral solution by hydrogen sulphide, the manganese acetate not being decomposed. Before the treatment with sodium acetate, the copper and arsenic were removed with hydrogen sulphide in an acid solution. Precipitation of the cobalt may also be made by the addition of potassium or barium sulphide. The sulphide precipitate was washed with cold dilute hydrochloric acid, which removed the sulphides of manganese, zinc, and iron, the cobalt sulphide remaining undissolved.[3]

A neutral solution of cobalt and nickel is mixed with potassium nitrite, potassium cobalt nitrite being formed. The presence of lime interferes with this separation, as a potassium lime nickel nitrite is precipitated at the same time.[4]

Barton and McGhie[5] separate cobalt and nickel from chloride solutions by subjecting the slightly acidified solution to fractional crystallization.

Miscellaneous Processes Summarized

Hybinette[6] outlines a process of separating copper from cobalt and nickel. The ore is roasted and the product separated by magnetic concentration. The magnetic concentrate, containing copper, cobalt, and nickel, is smelted to form a matte, which is roasted and leached with dilute sulphuric acid. A solution containing principally copper, and only small amounts of iron and cobalt, is obtained.

It has been proposed[7] to produce from sulphide ores a matte free from iron, and containing only sulphur, nickel, and cobalt. This matte was fused under a blast on a bed of quartz and sodium silicate in order to produce a silicate of cobalt. The latter compound was fused with soda and nitre to liberate the cobalt oxide. The method, however, does not appear to have come into use.

Richer[8] gives an interesting account of an old method to separate cobalt from nickel by crystallization from a solution containing a large quantity of ammonium sulphate. Mention is also made of the possibility of removing copper from cobalt oxide by heating with ammonium chloride.

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[1] Loujet, Monit. Indust., 1849, p. 1309.
[2] Phillips Wittstein, Repertorium für die Pharmacie, Vol. 57, p. 226.
[3] Wackenbroder, Gmelin Kraut, Handbuch der anorganischen Chemie, Band V, I, 1909, p. 193.
[4] Stromeyer, Jour. prakt. Chemie, Vol. LXVII, 1856, p. 185.
[5] German Patent 222,231, 1905. Metallurgie, Vol. VII, 1910, pp. 667-674.
[6] United States Patent, No. 1,098,443, June 2nd, 1914.
[7] Schnabel, Vol. II, p. 601.
[8] Tilloch, Phil. Mag., Vol. XIX, 1804, pp. 51-54.

Bücholz[1] outlines a method proposed to prepare cobalt and nickel oxides by dissolving the hydroxides in ammonia after precipitation.

Hauer[2] describes Patera's application of analytical methods for the production of cobalt and nickel oxides. In the process the iron and arsenic were precipitated with powdered calcium carbonate, the cobalt by calcium bleach, and the nickel by milk of lime.

Vivian[3] was granted a patent covering a process based on the affinity cobalt and nickel have for arsenic. In the specifications the claim is made that it is possible to separate cobalt and nickel from copper by regulating the amount of arsenic, and by having some sulphur present to combine with the copper.

Wright[4] proposed extracting cobalt and nickel from waste solutions from copper refining, by adding milk of lime, which precipitated the metals. After drying the precipitate it was mixed with sand, 15 to 20 per cent. of residue from the alkali works, 15 to 20 per cent. of carbon, and, if possible, with products containing arsenic. The cobalt and nickel were recovered as speiss.

Careis[5] proposed the following method to extract cobalt from ores. The ore was first dissolved in hydrochloric acid. The metals in solution were precipitated with soda, and the precipitate dissolved in sulphuric acid. The solution was neutralized with hot dilute sulphuric acid, whereby the copper and other metals, especially iron, were precipitated, the cobalt and nickel remaining in solution. The solution was mixed with hot ammonium or potassium sulphide, which precipitated the nickel. Metallic zinc was added to precipitate the cobalt from sulphate solution.

Grosse-Bohle[6] patented a process to precipitate cobalt and nickel from sulphate and chloride solutions by means of zinc.

Aaron[7] proposed precipitating cobalt and nickel from solutions as methylsulphocarbonates.

Neill[8] described the method used to treat the Mins la Motte ores.

Pelatan[9] published a clear description of the Herrenschmidt process as used at the Malétra works, Rouen, France.

Herrenschmidt and Capelle[10] issued a report for the French Government on the following processes: Carnot, Readman, Herrenschmidt, Clarke, Dixon, and Ratte.

Kripp[11] attempted to recover cobalt and nickel from copper ores containing silver. The silver was changed to chloride and removed, after which operation the

[1] Tilloch, Phil. Mag., Vol. XXIII, 1805, pp. 193-199.

[2] Jour. prakt. Chemie, Vol. LXVII, 1856, pp. 14-24.

[3] British Patent No. 13,800, Nov. 4, 1851; Percy, Metallurgy: Fuel, Clays, Copper, Zinc, etc., 1861, pp. 375-378.

[4] Bull. Soc. Chem., Vol. V (1st series), 1866, 475-476.

[5] Berg. u. hüttenm. Zeitung, Vol. XL, No. 23, 1881, pp. 215-216.

[6] German Patent No. 97,114, 1898. Abst. Fischer's Jahresbericht, Vol. XLIV, 1898, pp. 169-170.

[7] United States Patent, No. 330,454, Nov. 17th, 1885.

[8] Trans. Amer. Inst. Min. Eng., Vol. XIII, 1884-1885, pp. 634-639. Eng. Min. Jour., Vol. XXXIX, 1885, pp. 108-109.

[9] Genie Civil, Vol. XVIII, 1891, pp. 373-374.

[10] Moniteur Industriel, Vol. XV, 1888, pp. 145, 156, and 162.

[11] Wagner's Jahresbericht, Vol. XIV, 1868, pp. 111-112.

sulphur was precipitated with barium chloride, the iron by calcium carbonate, and the cobalt by a solution of calcium hypochlorite, stopping the precipitation at a reddish-coloured solution.

Hoepfner[1] was granted a patent covering the following process of treating cobalt ores. A matte was first produced, which was afterwards ground and treated with a cupric chloride solution. By this treatment the sulphides are dissolved, forming cuprous chloride. The metals were removed by electrolysis.

Hanes[2] gave some results obtained from the action of ammonia on cobalt-nickel arsenides. Hydroxides of cobalt and nickel are formed which dissolve in excess of ammonia. The metals may be obtained by electrolysis or by precipitation.

Metals Extraction Corporation[3] patented a process for the extraction and recovery of cobalt and nickel from ores and oxidized mattes. The ore or roasted matte was treated with magnesium chloride solution under pressure. The cobalt dissolved before the nickel.

Pederson[4] gave the results of an investigation of treating cobalt and nickel ores. The article deals more with ordinary chemical reactions.

Borchers[5] gave the following description of a process to treat ores and smelter products containing cobalt, nickel, and silver. The ores or products were first treated with alkaline bisulphate below 200° C., then roasted at 600 to 700°. The product was leached to remove the soluble sulphates. Refractory ores were first roasted with carbon.

Bernard[6] separated cobalt from nickel by precipitating the cobalt by hypochlorite that had been previously neutralized and freed from alkaline carbonates and caustic alkalies.

Lance[7] patented a process to separate the hydroxides of copper, zinc, cadmium, silver, nickel, cobalt, and tungsten. The process was based on fractional precipitation by ammonia.

Johnson[8] described a process for the treatment of copper matte containing cobalt, as follows. Matte containing copper 39 per cent., iron 1, cobalt 1, and sulphur 20 per cent., was crushed to 80-mesh and leached with hot 10 per cent. hydrochloric acid. The solution contained cobalt, nickel, and iron. The cobalt and iron were removed by treatment with chlorine and sodium carbonate or by hypochlorites.

Schreiber[9] devised the following process for the separation of cobalt, nickel, and manganese from crude liquors. The iron was precipitated first by the addition

[1] British Patent, No. 11,307, 1894. Abst. Jour. Soc. Chem. Ind., Vol. XIV, 1895, p. 754.

[2] Jour. Can. Min. Inst., Vol. VIII, 1905, pp. 358-362.

[3] French Patent, No. 367,717, July 4th, 1906. Jour. Soc. Chem. Ind., Vol. XXV, 1906, p. 1155.

[4] Metallurgie, Vol. VIII, 1911, p. 335. Abst. Jour. Soc. Chem. Ind., Vol. XXX, 1911, p. 900.

[5] British Patent, No. 18,276, August 8th, 1912. Jour. Soc. Chem. Ind., Vol. XXXII, 1913, p. 980.

[6] French Patent, No. 354,941, June 5th, 1905. Jour. Soc. Chem. Ind., Vol. XXIV, 1905, p. 1177.

[7] French Patent No. 342,865. May 3rd, 1904, second edition, Jan. 9th, 1905. Jour. Soc. Chem. Ind., Vol. XXIV, p. 845, 1905.

[8] United States Patent, No. 825,056, July 3rd, 1906.

[9] German Patent, No. 203,310, Sept. 29th, 1907. Jour. Soc. Chem. Ind., Vol. XXVII, 1908, p. 1158.

of calcium carbonate, then the copper by passing in hydrogen sulphide, and finally the cobalt practically free from nickel and manganese was precipitated with calcium hypochlorite. After removing the cobalt the precipitation was continued to precipitate the nickel and manganese, which was dissolved and re-precipitated.

Foote and Smith[1] discuss the dissociation pressures of certain oxides of copper, cobalt, nickel, and antimony.

Chesneau[2] prepared a number of the higher sulphides of cobalt and nickel and determined their solubility.

Mourlot[3] conducted a few experiments to determine the effect of high temperatures on copper, bismuth, silver, tin, nickel, and cobalt sulphides. He found cobalt sulphide is obtained by heating the anhydrous sulphate. At a high temperature it loses all the sulphur, the metal combining with any carbon present.

Manhès[4] claims to have devised an improved process for the treatment of arsenical and sulphide ores of cobalt and nickel. He first produced a speiss or matte which is either dissolved in hydrochloric acid or by electrolysis; or in a second dry refining process, air is blown through the matte which oxidizes the iron and sulphur. The metallic oxides formed by roasting were reduced to metal by carbon and lime, and the metal was used as anodes in the electrolytic refining. In a later patent[5] Manhès suggests adding coke in a converter for blowing matte. He also tried to prepare metallic cobalt and nickel from matte by adding fluxes to remove the sulphur.[6]

Garnier[7] also proposed blowing matte in a converter.

Langguth[8] describes a process used to smelt the cobalt and nickel ores of Norway. The ores were smelted in a blast furnace to produce a matte containing 30 per cent. cobalt and nickel. This was concentrated in a converter to 75 per cent., producing a slag containing 1 to 2 per cent. cobalt and nickel. The blowing operation required 20 to 25 minutes. Reference is also made to Manhès' work.

Savelsburg[9] described a process of blowing nickel and cobalt matte in a converter. Ground matte was blown without the application of heat to oxidize the iron without changing the sulphur content. The product was in a sintered condition satisfactory for melting.

Savelsburg and Papenburg[10] patented a process to convert oxide ores, especially those of cobalt and nickel, into sulphides. Crushed ore was mixed with sulphides and carbon, and briquetted. These were heated in a kiln furnace.

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[1] Jour Amer. Chem. Soc., Vol. XXX, 1908, pp. 1344-1250.

[2] Comp. Rend., Vol. CXXIII, 1896, pp. 1068-1071. Abst. Jour. Chem. Soc. (London), Vol. LXXII (2), 1897, p. 172.

[3] Comp. Rend., Vol. CXXIV, 1897, pp. 768-771. Abst. Jour. Chem. Soc. (London), Vol. LXXII, 1897, pp. 372-373.

[4] Jour. Soc. Chem. Ind., Vol. IV, 1885, p. 120.

[5] British Patent, No. 17,410, 1888; German Patent, No. 47,444, 1888.

[6] Jour. Soc. Chem. Ind., Vol. XIV, 1895, p. 581. British Patent, 6,914, 1894; German Patent, No. 47,427, 1894.

[7] Eng. and Min. Jour., Vol. XXXVI, 1883, p. 393.

[8] Min. and Sci. Press, Vol. LV, 1888, p. 102.

[9] German Patent, No. 222,231, Jan. 21st, 1908. Abst. Jour. Soc. Chem. Ind., Vol. XXIX, 1910, p. 1257.

[10] German Patent, No. 172,128, Jan. 21st, 1905. Abst. Fischer's Jahresbericht, Vol. LII, 1906, pp. 222-223.

Becquerel[1] applied the electric current to remove cobalt from solutions. The electrolysis was carried on in a cobalt chloride solution that had been neutralized with ammonia or caustic potash. Cobalt was deposited as a brilliant coating. Of the chlorine part escaped and part formed acid. The presence of too much acid gave a dark deposit.

Cohen and Solomon[2] were granted a patent for the electrolytic separation of cobalt from nickel. The addition of strongly oxidizing agents, especially persulphates, cause the precipitation of the cobalt first.

Le Roy[3] described an electrolytic method to extract cobalt and nickel.

Armstrong[4] patented a process for the treatment of complex cobalt ores and for refining cobalt and nickel arsenical and silver-bearing ores. The metals were obtained as chlorides, from which the cobalt was precipitated electrolytically as oxide.

Burlet[5] attempted to extract cobalt, nickel or copper from ores or products as follows. The silicate ore or slag was fused to remove the greater part of the copper as impure metal. The slag was then ground and treated with sulphuric acid. The iron and part of the copper were precipitated with calcium carbonate. The remaining copper, cobalt, and nickel were removed by electrolysis.

Wiggin and Johnstone[6] suggested improvements in the preparation of cobalt and nickel oxides. A cobalt-nickel-copper solution was electrolyzed, using a copper or brass cathode and a carbon anode. The copper was deposited, leaving in solution the cobalt and nickel, which were recovered in the ordinary way.

Martin[7] reduced cobalt and nickel as well as other metals in the ores by passing hydrocarbons over the ore at a bright red heat. The metals were afterwards recovered as an alloy by melting.

Mindeleff[8] attempted to extract cobalt and nickel from ores by reducing the compounds with hydrocarbons, and removing the metals obtained with a magnet.

Berndorfer Manufacturing Company[9] produced malleable and ductile nickel and cobalt by mixing the powdered metal with potassium permanganate, maximum 4 per cent., and melting the mixture.

Selve and Lotter[10] obtained nickel and cobalt free from oxides by the addition of 1.5 per cent. manganese during melting.

Krupp[11] found that cobalt and nickel were not malleable owing to the presence of carbon, but that the defect could be removed by adding manganate or permanganate of potash.

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[1] Comp. Rend., Vol. LVIII, 1862, pp. 18-20.
[2] German Patent, No. 110,615, 1900. Fischer's Jahresbericht, Vol. XLVI, 1900, p. 157.
[3] Bull. Soc. Industrielle de Mulhouse, Procès-verbeaux, Vol. LXXI, 1901, pp. 154-155.
[4] United States Patent, No. 881,527, March 10th, 1908.
[5] British Patent, No. 27,150, Nov. 25th, 1913. Abst. Jour. Soc. Chem. Ind., Vol. XXXIII, 1914, p. 1014.
[6] British Patent, No. 3,923, March 27th, 1885. Abst. Jour. Soc. Chem. Ind., Vol. V, 1886, p. 172.
[7] German Patent, No. 18,303, June 1st, 1881. Fischer's Jahresbericht, Vol. XXVIII, 1882, p. 120.
[8] British Patent, No. 10,491, Sept. 4th, 1885. Abst. Jour. Soc. Chem. Ind., Vol. IV, 1885, p. 746.
[9] German Patent, No. 28,989, 1884.
[10] German Patent, No. 32,006, 1885. Abst. Fischer's Jahresbericht, Vol. XXXII, 1886, p. 168.
[11] British Patent, No. 1464, 1884. Abst. Jour. Soc. Chem. Ind., Vol. III, 1884, p. 261.

Winkler[1] states that in the preparation of cobalt and nickel castings, a high temperature is necessary, refractory crucibles should be used, carbon and silicon should not come in contact with the molten metal, and that the metal must be protected from the atmospheric oxygen during casting.

Fleitmann[2] proposed a method to remove the brittleness in cobalt and nickel metal by adding magnesium before pouring.

Fink[3] outlines a process for the treatment of ores from Cobalt, Canada. The ore is ground to 40-mesh and mixed with fluxes to reduce the metals and make a slag. The charge is heated in a furnace at a temperature of 1,200 to 1,500° C. under reduced pressure for several hours. The arsenic is volatilized and condensed as metallic arsenic; and metallic silver, cobalt, and nickel speiss and slag are also formed. The products are further treated by known methods.

Levat, in a paper read before the French Association for the Advancement of Sciences, Sept. 29, 1887, gave the results of an investigation of the nickel, cobalt, and chromium ore deposits of New Caledonia.

Heard[4] gave a summary of the possibilities of the New Caledonia deposits.

2.—The Production of Smalt

Smalt is a potash aluminum cobalt silicate. It is prepared by melting together silica, potassium carbonate, and roasted cobalt ore. It was used extensively a number of years ago to produce blue-coloured glass and enamels. Owing to the difficulty in obtaining the same quality of colour intensity with different cobalt ores, the manufacture of smalt has gradually been abandoned. Cobalt oxides of uniform composition can be readily obtained, and these are used at present to prepare the different colours.

The production of smalt was formerly carried on chiefly in Saxony, and it is interesting to note that the Chinese have also prepared smalt for a number of years.

The first record of cobalt being used in Europe to colour glass dates from about 1540. It is stated a Nuremberg glass-maker was the first to try melting cobalt ore, termed "Kobold," with glass, and he obtained, much to his astonishment, a beautiful blue-coloured product.

A brief account of the operations as conducted in Saxony and China is given in the following paragraphs.

The Method Employed in Saxony to Prepare Smalt

The mineral was crushed, sorted and washed. This product, called "Schlich," was roasted in a rotary furnace, any arsenic evolved during the roasting being collected. During the roasting the cobalt was converted into oxide. The roasted product was finely ground and screened through a silk sieve, the powder being known as "zaffer" or "zaffler."

[1] Chem. News, Vol. XXXV, 1877, p. 166.
[2] Chem. News, Vol. XL, 1879, p. 67.
[3] United States Patent, No. 1,013 931, Jan. 9th, 1912.
[4] Eng. Min. Jour., Vol. XLVI, 1888, p. 103

To prepare smalt the roasted ore was mixed with sand and potassium carbonate and melted in a crucible. Crushed quartz was used for sand. Before being crushed, it was heated to a red heat in a lime kiln, crushed in stamp-batteries, washed to remove any light impurities, dried, and again heated to redness. The cobalt, being more readily oxidized than the nickel, passed into the slag, the nickel, combining with any arsenic, forming a speiss which settled to the bottom of the crucible. Any iron present was oxidized to ferric oxide, which is less injurious than ferrous oxide. The speiss was withdrawn either through an opening in the bottom of the crucible or carefully removed with a ladle. The purer the materials employed in the preparation, the more beautiful the product. The blue glass or slag containing the cobalt was poured into water, dried, and finely ground. The ground glass or smalt was mixed with water and allowed to stand for half an hour, during which time the coarse particles, known as "Streublau," settled. The coarse particles were afterwards reground.

The turbid water from the first washing was decanted into a second tank in which the pigment proper, termed couleur, settled to the bottom.

After twenty-four hours the turbid water was decanted into a third tank in which it remained until it was clear, when the finest and palest glass powder, "Aeschel," settled. The pigment, and also the aeschel, was next washed two or three times, the wash waters being filtered. The pigments in the various settling tanks were dried, screened, and packed into barrels.

About three-fifths of the glass taken from the pots was recovered. The presence of oxides other than those of cobalt and potash, even in small quantities, exerts a marked influence on the colour of the smalt. Barium produces an indigo tinge; sodium, calcium, and magnesium produce a reddish shade; iron, a blackish green, very objectionable in the brighter-coloured smalts; manganese, violet; nickel, violet, but less intense; copper, zinc, bismuth, and antimony, dull shades.

The smalt is classified according to its degree of fineness into coarse blue (Streublau) pigment, and Aeschel, the first size being denoted in the trade by H, the second by C, and the finest by E.

Respecting the intensity of the colour, each sort is distinguished as fine, middle, and ordinary by the letters F, M, and O. In the first class, colours of varying degrees of intensity are denoted by the letters, F, FF, FFF, FFFF, expressing two-fold, three-fold, and four-fold respectively. Qualities poorer in cobalt than the OC quality are distinguished by the use of indices, e.g., OC^2 (i.e., containing half the cobalt in the OC quality).

Smalts which contain more cobalt than the F quality are distinguished by doubling the latter F.

More intense than the last, FFFF, which is termed "Azure," or "King's Blue," do not occur.

The following list[1] gives the different brands of smalt:—

H .... Ordinary smalt.
E .... Aeschel.
B .... Bohemian smalt.
CF .... Ground pigment.

[1] Grünwald, Raw Materials of the Enamel Industry, 1914, p. 146.

FC .... Fine pigment.
FCB .... Fine Bohemian pigment.
FE .... Finer Aeschel.
MC .... Average.
MCB .... Average Bohemian.
ME .... Average Aeschel.
OC .... Ordinary pigment.
OCB .... Ordinary Bohemian pigment.
OE .... Ordinary Aeschel.

The different colours are spoken of as azure blue, smalt blue, zaffer blue, Saxon blue, enamel blue, cobalt blue, etc.

The following are analyses of some varieties of smalt:

Percentage Composition of Some Typical Smalts

Component	Norwegian Smalt		German Smalt			French Smalt				
	Dark	Dark Aeschel	Pale	Coarse Blue	Pigment C.	I	II	III	IV	V
Silica	70.86	66.20	72.11	72.21	70.11	75	70	65	63	60
Cobalt oxide	6.49	6.75	1.95	20.54	21.58	20	26	30	30	30
Potash	21.41	16.31	1.80	6.75	7.20	2	3	5	7	10
Alumina	0.43	8.64	20.04	0.22	0.11	....	....	....	....	....
Arsenious acid	....	....	....	....	....	1	1	1	1	1

There is also a French method of smalt preparation which consists in melting together cobalt oxide with quartz and potash. In this way a first-class product of desired intensity can be prepared, although the process is correspondingly more expensive.

The quartz is heated to redness and ground as in earlier methods, only instead of cobalt speiss pure cobalt oxide is here employed. The smalt so obtained is very pure, and more durable than the ordinary product.

The Chinese Method of Manufacturing Smalt[1]

In the Chinese glass works at Canton, the so-called lam-o-li-shek, i.e., "stone for blue glass," is employed for the production of a blue colour in glass and porcelain. It appears as if the Chinese are unaware how to produce colourless glass. They purchase glass fragments from Europe and America, which they classify according to colour and quality, and melt them in pots, 67 cm. at the top. One or two of these pots are placed in a rectangular furnace of primitive construction, which is heated with anthracite, for which purpose from 150 to 200 kg. of anthracite per pot are required. The blowpipe is short and wide, while the moulds are made of clay and dust. It is astonishing how the Chinese, by means of their small apparatus, are able to separate the cobalt from the iron, manganese and nickel, even when the cobalt content in the ore does not exceed 2 to 4 per cent.

[1] Bowler, Chemical News, Vol. LVIII, 1888, p. 100.

The crude cobalt mineral is first carefully washed, and every piece is scrubbed with a brush, in order to remove the adhering clay which contains iron. The ore is next dried and pulverized, then afterwards ground in a hand mill with water. The whole mixture is then conveyed to a vessel, in which it is vigorously stirred for several hours, after which it is allowed to settle over night. On the following day the water is decanted, taking with it the upper layer of the settled powder. The latter consists of the lighter earthy substances, while the residual mass is the oxides of iron, manganese, nickel and cobalt. This mass is removed, mixed with a small quantity of borax, and placed in one of the above-mentioned pots containing the glass. The melting is now carried out, and during the first twelve hours the fused mass acquires a dirty greenish-black colour. By degrees this mixed colour changes to a bright bluish-violet similar to amethyst. It appears as if the iron and nickel are completely reduced, for after 36 to 40 hours' heating scarcely any of the iron or manganese colour can be detected in the mixture.

The lowest portion of the fused glass in the pot is rejected. This part probably contains the impurities, such as iron, nickel, manganese, etc.

For the purpose of porcelain painting, the Chinese frit the same mineral with feldspar, kaolin, and much borax. This frit is ground to fine powder, and employed for painting on the biscuit. The Canton process is as follows:

The manipulator takes the burnt biscuit and covers this with a glaze consisting of borax, feldspar, and clay, which, when sufficiently dry, he paints upon, and in one single operation burns in both the enamel and colour.

An analysis of the mineral is given as follows: Iron oxide 35.0, Manganese oxide 13.1, Nickel oxide, 3.5, Cobalt oxide, 3.5, gangue 46.0 per cent.

The gangue consisted for the most part of silica and aluminium silicate.

Preparation of Metallic Cobalt

Metallic cobalt may be obtained from the oxide or oxalate by one of the following methods. Cobalt oxide is obtained by heating precipitated cobalt hydroxide or oxalate.

Reduction of the oxide in a carbon crucible or by the addition of carbon or starch.[1]

Reduction of the oxide[2] or oxalate[3] in a stream of hydrogen or hydrocarbons,[4] the reduction being complete at 500 to 600° C.

Reduction of the oxide by carbon monoxide.[5]

Reduction of the oxide by ammonium chloride.[6]

Reduction of cobalt chloride in a current of hydrogen.[7]

Reduction of the oxide by aluminium.[8] Goldschmidt process.

Precipitation from cobalt solutions by metallic magnesium.[9]

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[1] Berthier, Annales de Chemie et Physique, Vol. 25, 1824, p. 98. Winkler, Jour. prakt. Chem., Vol. XCI, 1864, p. 213. Kalmus, Preparation of Metallic Cobalt by Reduction of the Oxide: Department of Mines, Canada, Bulletin No. 259, 1913, p. 4. Moissan, Comp. Rend., Vol. 116, 1893, pp. 349-351.

[2] Muller, Annalen der Physik und Chemie, Vol. CXXXVI, 1869, p. 51. Moissan, Annales de Chem. et Physique, 1880, Vol. V, sec. 21, p. 199. Glasser, Zeitschr. anorg. Chem., Vol. XXXVI, 1903, p. 19. Kalmus, Bulletin 259, p. 11.

[3] Wolff, Zeitschr. anal. Chem., Vol. XVIII, 1879, p. 38. Berzelius, Gmelin Kraut, Handbuch der anorganischen Chemie, 1909, Band. 5, 1, p. 194. Brunner, Idem, p. 194.

[4] Martin, German Patent, No. 18303, June 1st, 1881. Fischer's Jahresbericht, 1882, Vol. 28, p. 120.

[5] Mond, Hirtz, and Copaux. Note on a volatile compound of cobalt with carbon monoxide: Chem. News, Vol. XCVIII, 1908, p. 165. Mond Nickel Co., Hirtz, and Copaux, British Patent, No. 13,207, 1908: a patent covering the manufacture of cobalt carbonyl or carbonyls by heating cobalt or material containing cobalt in carbon monoxide or gas containing the latter. Kalmus, Bulletin 259, p. 25.

[6] Rose, Gmelin Kraut, Handbuch der anorganischen Chemie, Band V. 1, 1909, p. 192.

[7] Peligot, Compt. Rend., Vol. XIX, 1844, p. 670. Baumhauer, Zeitschr. anal. Chem., Vol. X, 1871, p. 217. Schneider, Annalen der Physik und Chem., Vol. CI, 1857, p. 387. Wagner, Jahresbericht, 1857, p. 226.

[8] Kalmus, Bulletin 259, p. 32.

[9] Siemens, Zeitschr. anorg. Chem., Vol. XLI, 1904, p. 249.

Distillation of cobalt amalgams.[1]

Electrolytic methods.[2]

Fink[3] proposes the following treatment for the production of metallic cobalt. Powdered smaltite is mixed in the proper proportion with powdered lime and calcium carbide and heated in a vacuum for 1 to 2 hours, at a temperature of 1500° C. The reaction of lime and calcium carbide yields metallic calcium, which in turn reacts with the cobalt arsenide, forming calcium arsenide and metallic cobalt.

Precipitation of cobalt from solutions by zinc.[4]

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Development of the Metallurgy of the Ontario Silver-Cobalt Ores

In reviewing the development of the metallurgy of the silver-cobalt ores of Ontario, it is necessary to make three divisions, viz., the progress in ore-dressing methods, the introduction of new processes in the extraction of the silver, and the improvements in the treatment of the ores for the cobalt. At the same time, it cannot be too strongly emphasized that co-operation and publicity of results have contributed no small part to the success achieved in the treatment of the Cobalt ores.

The importance of the Cobalt deposits may best be realized from the following figures. In 1903 when the silver deposits of Cobalt were discovered, Canada produced silver valued at $1,709,642, while in 1913 the production was valued at $19,040,924. During the same period the value of the annual production of cobalt rose from practically nothing to $500,000. Besides the value of cobalt, appreciable returns are realized from the arsenic and nickel.

Previous to the discovery of the deposits at Cobalt, most of the world's supply of cobalt ore was shipped from New Caledonia to Europe for treatment. In fact,

[1] Moissan, Compt. Rend., Vol. LXXXIII, 1879, p. 180; Bulletin Soc. Chem., Pt. II, Vol. XXXI, 1879; p. 149; Annalen de Chem. et. Physique, Vol. V, 1880, p. 21, p. 199. Guertler, Metallographie, Vol. I, 1912, p. 513.

[2] Kalmus, Electro-plating with Cobalt, Bulletin No. 334, Department of Mines, Canada, 1915. Becquerel, Comp. Rend., Vol. LVIII, 1862, pp. 18-20.

[3] United States Patent, No. 1,119,588, Mineral Industry, Vol. XXIII, 1914, p. 548.

[4] Careis, Berg-u. huttenm. Zeitung, Vol. XL, No. 23, 1881, pp. 215, 216.

until 1908 Europe practically controlled the world's production. In 1908 cobalt products from Canadian and American smelters were placed on the market, and this caused the price of cobalt oxide to fall from $2.00 to $1.00 a pound. Cobalt oxide is at present (1917) selling for $1.50 per pound.

Progress in Ore Dressing

The progress in ore dressing at Cobalt has been brought about by the diminution in the grade of the ore and the attempt to obtain increased recoveries. At first the high-grade ore (2,000 oz. or more) was readily hand-picked from the low-grade and shipped as such. In order to keep up the grade of the shipments, concentration methods were introduced extensively during 1907-1908. For the coarser crushing it is customary to use one of the following combinations: stamps crushing to approximately 20-mesh; crushing in stamps to 0.25-inch, followed by sizing and concentrating, the fine tailing going to waste, the coarse being reground in pebble mills; and crushing in rolls or in ball mills to about 0.25-inch, concentrating, and regrinding the tailing in pebble mills. In 1914 about 75 per cent. of the ore milled was crushed by stamps to 14 to 20-mesh.

Classification is used extensively to separate the sand from slime. In the concentrating mills hindered-settling types of classifiers are employed, while in the cyaniding plants the Dorr classifier is common. For sand concentration the Wilfley, James, and Deister tables are mostly used, while for treating slime the James and Deister tables are preferred, although canvas tables were employed to some extent. The sand tailing averages 3 to 4 ounces and the slime tailing 6 to 8 ounces of silver per ton, but it is not possible to recover the silver from these products by the ordinary gravity concentration methods. The average ratio of concentration in the Cobalt mills is 50 to 1.

The recovery of the silver from the tailing dumps and low-grade ores has been one of the problems that has confronted the metallurgists at Cobalt for some time. At present there are about 2,500,000 tons of tailing, averaging 4 to 6 ounces of silver. To treat these accumulated residues and the low-grade ores, flotation methods seem most suitable. In October, 1915, the first experimental flotation plant was erected by the Buffalo Mines, Limited. This plant consisted of a two-compartment, standard length Callow rougher cell, and a one-half size Callow cleaner cell. The results obtained by flotation were so encouraging that a flotation plant to handle 600 tons daily was erected and put into operation in September, 1916. At present the Buffalo Mines, McKinley-Darragh-Savage Mines, Nipissing Mines, Coniagas Mines, Dominion Reduction Co., Northern Customs Concentrators, and National Mines (King Edward) employ the Callow system of flotation.

To prepare the tailings and low-grade ores for flotation, fine grinding to 100-mesh is necessary. Pebble mills are commonly used for this purpose. The oil used consists of a mixture of 15 per cent. pine oil, 75 per cent. coal tar creosote, and 10 per cent. coal tar. Further experiments have shown that an oil obtained from the distillation of hard wood in charcoal plants is well suited for flotation. The results obtained by flotation are about as follows: feed 6 to 10 oz. of silver, concentrate 250 to 1,000 oz., tailing 0.8 to 2.5 oz., and a recovery of 80 to 90 per cent.

The recovery of the silver from the flotation concentrate has been accompanied with difficulties, and at present most of the concentrate is shipped to the smelters in the United States. Under present conditions the freight and treatment charges on the flotation concentrate amounts to about 20 per cent. of the value of the product. The flotation concentrate produced at the Buffalo Mines was treated at Cobalt. The method employed is to give the concentrate a roast with salt, a leach with hydrochloric acid, and a treatment with salt solution, the silver being finally recovered by precipitation on scrap copper, and the copper by passing the solution over scrap iron. The above treatment has been discontinued by the Buffalo Mines company, but is still being practised by the Dominion Reduction company.

Progress in the Metallurgy of Silver

In the early operation of the Cobalt camp, most of the silver was recovered by smelting methods, the ore shipped averaging 2,000 ounces or more per ton. The presence of large quantities of arsenic caused trouble in the smelting and refining processes, and it was necessary for the smelters to levy a penalty on excessive quantities. There was also a high treatment charge because of the difficulty in smelting the high-grade silver ores. The freight rate on the high-grade ore was also heavier.

In order to obtain a better return from the silver contents of the high-grade ore, experiments were undertaken to devise a process for treating the high-grade ores at Cobalt and obtaining the silver as bullion. The Nova Scotia mill, now the Dominion Reduction, was the first to recover bullion by amalgamation and cyanidation. This mill treated the run-of-mine ore, which included the high-grade, and produced bullion and a residue assaying about 150 ounces of silver per ton. The Nipissing improved on the process by substituting a tube mill for the amalgamating pan. The combination process of amalgamation and cyanidation is used at three mills, viz., the Nipissing and Buffalo on high-grade ore and concentrates, and the Dominion Reduction on concentrates only. The process is usually carried out as follows: With 2,500 oz. ore, a charge would be 6,500 pounds of 20-mesh ore, 8,500 pounds of mercury, 3,800 pounds of 5 per cent. cyanide solution, and 6 tons of pebbles. After 9 to 10 hours' treatment the pulp will all pass a 200-mesh screen, and contain about 50 oz. of silver per ton. It is given a further agitation for 36 hours in a 0.75 per cent. cyanide solution when the silver is reduced to 30 ounces.

The treatment of low-grade ores at Cobalt has for a number of years presented a difficult but interesting problem. It is possible to treat the low-grade ores by concentration methods, by a combination of concentration and cyaniding, and by flotation. It appeared as if flotation in combination with concentration or cyanidation was the most suitable, but recent developments tend in some cases to favor concentration and cyanidation. Very little cobalt and nickel are recovered in the flotation concentrate.

Amalgamation was not practicable on low-grade ores, so attention was turned toward cyanidation. After extensive experiments it was found that it was not possible to treat the low-grade complex ores by the ordinary cyanide process, because the solutions quickly became foul, thereby diminishing the dissolving

power; besides, the cyanide consumption was excessive. To overcome these difficulties a process known as the "Wet Desulphurizing Process" was devised by the Nipissing Mining Company.

Briefly, this process consists in giving the ground ore a treatment with alkali and aluminium. The preliminary treatment is given in tube mills, and the final treatment in tanks. In the preliminary treatment the ore is ground in an 0.25 per cent. caustic soda solution with an addition of 5 pounds of lime per ton of ore. The lime is added to hasten settling. In the process the refractory minerals, especially pyrargyrite and proustite, are decomposed, the sulphur, arsenic, and antimony being reduced to the elemental or metallic state. The reduced sulphur, arsenic, and antimony have practically no action on cyanide. The reactions involved may be expressed as follows:

$$2Al+2\ NaOH+2H_2O=Na_2Al_2O_4+6H.$$
$$6H+3\ Ag_2S+6NaOH=3Na_2S+6H_2O+6Ag.$$
$$6H+Ag_3SbS_3+6NaOH=3Na_2S+6H_2O+3Ag+Sb.$$
$$6H+Ag_3AsS_3+6NaOH=3Na_2S+6H_2O+3Ag+As.$$

With fine grinding and after treating the ore by the wet desulphurizing process, the silver may be readily extracted in 48 hours by treatment with a 0.25 per cent. cyanide solution. By the desulphurizing treatment a saving of one to four ounces of silver is obtained at an additional cost of 54 cents per ton of ore. On a 20-ounce feed a saving of four ounces means an increased extraction of 20 per cent.

The precipitation of the silver from the cyanide solutions by zinc presented a further difficulty, but the substitution of aluminium dust overcame this. The advantages of the aluminium dust in precipitation may be stated as follows: a high-grade precipitate is obtained, there is little fouling of the cyanide solutions, and during the precipitation an amount of cyanide proportional to the silver precipitated is regenerated. One part of aluminium dust will precipitate about three parts of silver. Aluminium dust was used until 1916, but owing to the difficulty of obtaining it and also to the increased cost, other precipitants are being tried. At present at the Nipissing mill sodium sulphide is used to precipitate the silver, and the sulphide precipitate is desulphurized by treatment with caustic soda and aluminium, metallic silver being produced.

Aluminium dust precipitation was first used by the Deloro Smelting and Refining Company, then by the O'Brien mine, and later by the Nipissing and Buffalo and other mines at Cobalt.

Progress in the Metallurgy of Cobalt and Nickel

Before the discovery of the large silver-cobalt-nickel deposits at Cobalt, very little was known in Canada of the properties and metallurgy of the metal cobalt and its compounds, except that cobalt silicate possessed a beautiful colour and was used in the ceramic industries. Cobalt was considered one of the rarer metals.

Cobalt ores had been treated in Europe for centuries, but the treatment was conducted on a small scale, and the methods were what might be called large laboratory methods. There were about 25 plants operating in Europe, and these

were producing about one-half the quantity of cobalt that is now being turned out annually by the three Canadian smelters. The method formerly employed was to dissolve the ore, matte or speiss in either hydrochloric or sulphuric acid, and remove the impurities by chemical methods. The copper was often removed by hydrogen sulphide gas, and after eliminating any gas in solution by boiling, the iron, cobalt, and nickel were precipitated. The high price of cobalt oxide enabled the operators to work on a small scale, even though the grade of the ore would not average over 3 per cent. cobalt.

After the discovery of the cobalt deposits in Canada, it soon became evident that they were of sufficient extent to justify the attempt to establish a cobalt smelting industry in Canada. It was soon seen that new processes would have to be devised, or the old methods improved. The cost of acids and chemicals, the operating difficulties, and the higher cost of labour made the old processes prohibitive in Canada, and at the same time it was not possible to operate them on a considerable scale. The larger proportion of cobalt and the presence of large quantities of arsenic in the Canadian ores, also made it necessary to modify the older processes.

In the processes in use in Canada at present, the gangue minerals, and most of the arsenic and iron are removed in blast furnaces. The products of the blast furnace are: metallic silver, an argentiferous speiss containing cobalt, nickel, and iron as arsenides, also slag and flue dust. The large quantities of silver and arsenic in the cobalt-nickel ores are a source of revenue to the smelters. The argentiferous speiss made in the blast furnace is roasted to about 10 per cent. arsenic, given a chloridizing roast, and the product cyanided. The successful cyanidation of such a complex furnace product was a new departure in cyaniding. The residue is sulphated with sulphuric acid, and the iron is rendered insoluble by heating. In this treatment with acid the cobalt and nickel dissolve, as well as some of the iron and arsenic. The iron and arsenic must be removed before the precipitation of the cobalt and nickel, with solutions of bleaching powder. The grade of cobalt oxide produced by the Canadian smelters is considerably better than that produced by the European refineries. The production of a higher grade oxide at a lower price was necessary to compete with and secure the closely controlled trade of Europe. Both these difficulties were finally overcome by the improvements in and the efficiency of the Canadian processes.

In summarizing, it may be stated that the progress in the metallurgy of cobalt and nickel has not been owing so much to the introduction of new methods as to the development of the old ones on a larger and more efficient scale.

The general progress in the development of the metallurgy and ore dressing of the silver-cobalt-nickel ores has been due to the grade and value of the ore, and to the co-operation of the operators. It would be impossible to mention all those who have contributed to the success of the Cobalt camp, but special mention should be made of the work of Reid and Moffat in ore dressing; of Denny, Fairlie, Jones, and Clevenger in the metallurgy of silver; and of Kirkpatrick and Peek in the metallurgy of cobalt and nickel.

The wet desulphurizing process used in connection with the low-grade ores, and the introduction of the use of sodium sulphide to precipitate the silver,

were developed by J. J. Denny, metallurgist of the Nipissing Mining Company. Prof. S. F. Kirkpatrick was the first to introduce the use of aluminium dust for the precipitation of silver, but his chief work has been in the development of the metallurgy of cobalt and nickel. Under his direction the Deloro Smelting and Refining Company has become the largest smelter treating cobalt ores and also, due mostly to his initiative, a plant has been erected to smelt the complex cobalt ores of Missouri. Difficulties have constantly arisen in the treatment of ores of cobalt, but these have always been solved. The excellent work of Prof. Kirkpatrick in the development of the metallurgy of cobalt-nickel ores has been recognized by the profession, since in 1917 he was awarded the McCharles medal of the University of Toronto.

CHAPTER III

THE CHEMISTRY OF COBALT

The word cobalt is synonymous with "kobold," meaning goblin, which was a term given by the early miners to those ores which did not yield metal on smelting. It is stated[1] that an early form of the word cobalt appears in the writings of Basilius Valentinus about the end of the 15th century. Berthelot[2] states that the word is of Graeco-Egyptian origin. In Hoover's translation of Agricola's De Re Metallica, mention is made of the word cobalt as being from the Greek, cobalos.

The use of cobalt compounds for colouring glass was known to the ancients and, since 1600, cobalt minerals have been used for the preparation of smalt. In 1735 Brandt prepared some metallic cobalt by reduction from the ore.

Polished cobalt metal is silvery white in colour, but when reduced from the oxide, it is in the form of gray powder. The specific gravity varies from 8.79 on an unannealed sample to 8.92 on a swaged sample. The melting point of cobalt is given as 1478°C., and the tensile strength at about 34,400 pounds per square inch.[3] Metallic cobalt is magnetic. The atomic weight is 58.97.

Cobalt is soluble in dilute acids. The metal forms three oxides: cobaltous oxide (CoO) greenish gray; cobaltous cobaltic oxide (Co_3O_4) black; and cobaltic oxide (Co_2O_3) brownish. Cobaltous oxide is obtained from Co_3O_4 by heating at a high temperature. The usual method of preparing the oxides is to calcine, at a red heat, the hydroxide obtained by precipitation in one of the processes mentioned under the Metallurgy of Cobalt.

Cobalt forms with acids two compounds, cobaltous and cobaltic. Cobaltous compounds are pink in the crystallized state or in aqueous solutions, but yellow or green in the anhydrous condition, and blue when in aqueous solutions in the presence of hydrochloric acid.

By dissolving any of the three oxides in acids, salts derived from cobaltous oxide are always obtained, containing bivalent cobalt:

$$CoO+2HCl=H_2O+CoCl_2.$$

$$Co_2O_3+6HCl=3H_2O+2CoCl_2+Cl_2.$$

$$Co_3O_4+8HCl=4H_2O+3CoCl_2+Cl_2.$$

Simple cobaltic salts are unknown, but many complex compounds exist with trivalent cobalt, as, for example, potassium cobaltinitrite, potassium cobalticyanide, and numerous cobalti-ammonia derivatives.

Reactions of Cobalt Salts[4]

Potassium or sodium hydroxide precipitates in the cold a blue basic salt:

$$CoCl_2+KOH=KCl+Co(OH)Cl,$$

which on warming is further decomposed by hydroxyl ions, forming pink cobaltous hydroxide:

$$Co(OH)Cl+KOH=KCl+Co(OH)_2.$$

[1] Gmelin Kraut, Handbuch der anorganischen Chemie, Band V, 1, 1909, p. 190.
[2] Idem, p. 190.
[3] Kalmus, The Physical Properties of Cobalt, Bulletin 309, Department of Mines, Ottawa, Canada, 1914.
[4] A number of the following reactions are taken from Treadwell Hall, Analytical Chemistry, Vol. I, fourth edition, 1916.

In the case of a moderately concentrated solution of the alkali the precipitate of pink cobaltous hydroxide is often produced in the cold, sometimes only after standing for some time. The rapidity of the reaction depends entirely upon the concentration of the alkali.

Cobaltous hydroxide gradually turns brown in contact with the air, forming cobaltic hydroxide:

$$2Co(OH)_2+H_2O+O=2Co(OH)_3.$$

In this respect cobalt behaves similarly to iron and manganese, but differs from nickel, for the hydroxide of the latter is not oxidized by atmospheric oxygen.

On adding chlorine, bromine, hypochlorites, hydrogen peroxide, etc., to an alkaline solution containing cobaltous hydroxide, cobaltic hydroxide is immediately formed, as with nickel and manganese:

$$2Co(OH)_2+2NaOH+Cl_2=2NaCl+2Co(OH)_3.$$

$$2Co(OH)_2+H_2O+NaOCl=NaCl+2Co(OH)_3.$$

From ammoniacal cobalt solutions the above oxidizing agents cause no precipitation, but merely a red colouration; the addition of potassium hydroxide then causes no precipitation, whereas in the case of nickel, a precipitate is formed.

Cobaltous hydroxide—$Co(OH)_2$, behaves under some conditions as a weak acid, for on adding to a cobaltous solution a very concentrated solution of KOH or NaOH the precipitate at first produced dissolves with a blue colour similar to that formed with copper compounds. By the addition of Rochelle salts, $KNaC_4H_4O_6$, to this blue cobalt solution the colour either disappears almost entirely or becomes a pale pink, while the similarly treated copper solution becomes more intensely blue. By the addition of potassium cyanide to the blue cobalt solution it becomes yellow, and in contact with air turns intensely brown. A copper solution would be decolourized by the addition of potassium cyanide.

By pouring a little cobalt solution (or adding a little solid cobalt carbonate) into a concentrated solution of caustic soda or potash, to which a little glycerol has been added, a blue solution is formed (the colour being intensified by warming), which after standing some time in the air, or immediately on the addition of hydrogen peroxide, becomes a beautiful green.

Ammonia precipitates, in the absence of ammonium salts, a blue basic salt, soluble, however, in excess of ammonium chloride. Ammonia, therefore, produces no precipitate in solutions which contain sufficient ammonium chloride. The dirty yellow ammoniacal solution is little by little turned reddish on exposure to the air, owing to the formation of stable cobalti-ammonia derivatives:

$$Co(OH)_2+2NH_4Cl+2NH_3=Co(NH_3)_4Cl_2+2H_2O.$$

Alkali carbonates produce a reddish precipitate of basic salt of varying composition.

Ammonium carbonate also precipitates a reddish basic salt, soluble, however, in excess.

Barium carbonate does not precipitate cobalt in the cold and out of contact with air, but on exposure to the air cobaltic hydroxide is gradually thrown down. The precipitation takes place much more quickly on the addition of hypochlorites or hydrogen peroxide:

$$2CoCl_2+2BaCO_3+3H_2O+NaOCl=NaCl+2BaCl_2+2CO_2+2Co(OH)_3.$$

If the solution is heated to boiling, all of the cobalt is precipitated as a basic salt, even out of contact with the air.

Hydrogen sulphide produces no precipitate in solutions containing mineral acids. In neutral solutions containing an alkali acetate, all of the cobalt is precipitated as black sulphide.

Ammonium sulphide precipitates a black sulphide,

$$CoCl_2+(NH_4)_2S=2NH_4Cl+CoS,$$

insoluble in ammonium sulphide, acetic acid, and very dilute hydrochloric acid; soluble in concentrated nitric acid and aqua regia, with the separation of sulphur:

$$3CoS+8HNO_3=4H_2O+2NO+3S+3Co(NO_3)_2.$$

By continued action of strong nitric acid all the sulphur goes into solution as sulphuric acid.

Potassium cyanide produces in neutral solutions a reddish brown precipitate, soluble in excess of potassium cyanide in the cold, forming brown potassium cobaltocyanide:

$$CoCl_2+2KCN=Co(CN)_2+2KCl.$$
$$Co(CN)_2+4KCN=K_4[Co(CN)_6].$$

On warming the brown solution for some time it becomes bright yellow and gives an alkaline reaction. It now contains potassium cobalticyanide, of analogous composition to potassium ferricyanide.

The formation of the cobaltic salt takes place in the presence of atmospheric oxygen:

$$2K_4Co(CN)_6+O+H_2O=2KOH+2K_3Co(CN)_6.$$

The reaction takes place more quickly in the presence of chlorine, bromine, hypochlorites, etc.:

$$2K_4Co(CN)_6+Cl_2=2KCl+2K_3Co(CN)_6.$$

An excess of chlorine, bromine, etc., does not decompose the cobaltic salt; in this particular it differs from nickel.

The cobalticyanide anion is much more stable than the cobaltocyanide anion. By adding hydrochloric acid to the brown solution of potassium cobaltocyanide, hydrogen cyanide (prussic acid) will be set free and yellow cobaltous cyanide formed,

$$K_4Co(CN)_6+4HCl=4HCN+4KCl+Co(CN)_2,$$

while potassium cobalticyanide is not decomposed by hydrochloric acid.

Potassium cobalticyanide forms, with most of the heavy metals, difficulty soluble or insoluble salts possessing characteristic colours. Thus, it produces with cobaltous salts pink cobaltous cobalticyanide:

$$2K_3[Co(CN)_6]+3CoCl_2=6KCl+Co_3[Co(CN)_6]_2,$$

and with nickel salts greenish nickel cobalticyanide. If, therefore, a cobalt solution contains nickel it forms, when treated with sufficient potassium cyanide to redissolve the cobalt precipitate, boiled, and acidified with hydrochloric acid, a greenish precipitate of nickelous cobalticyanide:

$$2K_3[Co(CN)_6]+3K_2[Ni(CN)_4]+12HCl=12HCN+12KCl+Ni_3[Co(CN)_6]_2.$$

Potassium nitrite produces in concentrated solutions of cobalt salts, in the presence of acetic acid, an immediate precipitation of yellow crystalline potassium cobaltic nitrite. If the solution is dilute, the precipitate appears only after standing for some time, but more quickly on rubbing the sides of the beaker.

The reaction takes place in the following stages:

$$CoCl_2+2KNO_2 \rightleftarrows Co(NO_2)_2+2KCl.$$

$$2KNO_2+2HC_2H_3O_2=2KC_2H_3O_2+2HNO_2.$$

The free nitrous acid oxidizes the cobaltous nitrite to cobaltic nitrite,

$$Co(NO_2)_2+2HNO_2=H_2O+NO+Co(NO_2)_3,$$

which now combines with more potassium nitrite:

$$Co(NO_2)_3+3KNO_2=K_3Co(NO_2)_6.$$

This reaction offers an excellent means of detecting the presence of cobalt in nickel salts.

Potassium nitrite produces in dilute nickel solutions no precipitate. In very concentrated solutions a brownish-red precipitate of $Ni(NO)_2.4KNO_2$ is thrown down; in the presence of alkaline earth salts a yellow crystalline precipitate is formed; e.g., $Ni(NO_2)_2.Ba(NO_2)_2.2KNO_2$, which is very difficultly soluble in cold water, but readily soluble in boiling water, with a green colour.

Ammonium thiocyanate (Vogel's reaction): If a concentrated solution of ammonium thiocyanate is added to a cobaltous solution, the latter becomes a beautiful blue, owing to the formation of ammonium cobaltous thiocyanate:

$$CoCl_2+2NH_4CNS=2NH_4Cl+Co(CNS)_2.$$

$$Co(CNS)_2+2NH_4CNS=(NH_4)_2[Co(CNS)_4].$$

On adding water the blue colour disappears and the pink colour of the cobaltous salt takes its place. If, now, amyl alcohol is added (or a mixture of equal parts of amyl alcohol and ether), and the solution shaken, the upper alcoholic layer is coloured blue. This reaction is so sensitive that the blue colour is recognizable when the solution contains only 0.02 milligrams of cobalt. The blue solution also shows a characteristic absorption spectrum. Nickel salts produce no colouration of the amyl alcohol. If, however, iron is present, the red $Fe(CNS)_3$ is formed, which likewise colours the amyl alcohol, making the blue colour due to the cobalt, indistinct, so that, under some conditions, it cannot be detected. If, a little sodium carbonate solution or a few c.c. of concentrated ammonium acetate and 2 or 3 drops of 50 per cent. tartaric acid are added, the iron will be precipitated, the red colour produced by $Fe(CNS)_3$ will disappear, and the blue colour produced by the cobalt will be seen.

The above reaction serves as an excellent means of detecting cobalt in the presence of nickel.

Ether saturated with hydrochloric acid does not precipitate an anhydrous cobaltous salt, as in the case of nickel, but will dissolve the blue, anhydrous cobaltous chloride. This furnishes the basis of a method for separating nickel and cobalt.

α-Nitroso-β-naphthol, $C_{10}H_6(NO)OH$, produces a voluminous, purple red precipitate of cobalti-nitroso- -naphthol, $[C_{10}H_6(NO)O]_3Co$, which is insoluble in cold, dilute nitric or hydrochloric acid.

This reagent serves not only for qualitative purposes, but can also be used for the quantitative determination of cobalt in the presence of nickel. The test may be applied conveniently to the solution obtained in the usual qualitative scheme after the removal of all metals except nickel and cobalt. A part of the solution may be used for the sensitive nickel test with dimethylglyoxime, and the

remainder used for the cobalt test. To test for cobalt dilute the solution to about 50 c.c., add 4 c.c. of 6N hydrochloric acid and 20 c.c. of 6N acetic acid. Heat and add 50 c.c. of a saturated solution of nitroso-β-naphthol and boil in 50 per cent. acetic acid. If as much as 0.1 mg. of cobalt is present, a red precipitate or turbidity is obtained even in the presence of 250 mg. of nickel. When more than 150 mg. of nickel are present, however, some of the brownish-yellow nickel compound, $[C_{10}H_6(NO)O]_2Ni$, will precipitate after the solution cools.

The reagent used in this test should be freshly prepared. Nitroso-β-naphthol gradually decomposes on standing in the air, and changes from yellow to brown or even black in colour. It can be purified by dissolving in hot sodium carbonate, filtering, and reprecipitating with sulphuric acid. For ordinary purposes the saturated solution in 50 per cent. acetic acid is most suitable. The cobalt test can be made more delicate by adding an equal volume of alcohol to the test and, for detecting traces of cobalt, an aqueous solution of the organic substance can be used, but as 5,000 c.c. of water are required to dissolve 1 gram of the nitroso-β-naphthol, it is evident that the aqueous solution is not suitable when much cobalt is present. An excess of the reagent is required, as a part of it is used to oxidize the cobalt to the trivalent condition.

Copper gives a characteristic coffee-brown precipitate with the reagent, and it is possible to separate copper from lead, cadmium, etc., by means of it. Ferric iron gives a brownish-black precipitate which serves as a means of separating iron from aluminium, manganese, etc. Ferrous iron also gives a greenish precipitate in neutral solutions. Of all these precipitates, however, the cobalt compound is the most characteristic and the least influenced by the presence of acid. Thus with the acidity recommended above, the presence of a little ferric or ferrous iron causes no disturbance.

Reactions in the Dry Way

The bead produced by borax or sodium metaphosphate with cobalt salts is blue in both the oxidizing and reducing flames. By holding the bead in a reducing flame for a long time it is possible to reduce the cobalt to metal, when it appears, like nickel, gray.

On charcoal, cobalt compounds yield gray metallic cobalt, which can be removed by means of a magnet. The metal is placed on filter-paper, dissolved in hydrochloric acid and dried. The paper is then coloured blue by cobalt. If, now, sodium hydroxide is added and the paper exposed to the action of bromine vapours, black cobaltic hydroxide, $Co(OH)_3$, is formed.

Salts of cobalt when strongly heated with alumina give a blue-coloured compound, Thenard's blue, possibly $CoOAl_2O_3$.

Quantitative Determination of Cobalt and Nickel

In Oxidized Ores

The colorimetric method outlined below was used to determine cobalt and nickel in the ores of New Caledonia.

A 10 gram sample of the finely ground mineral was treated with hydrochloric acid and boiled to obtain complete decomposition and also to expel the chlorine

which is set free in the reaction. By this treatment all the metals should be converted to soluble chlorides, leaving a residue of silica.

The solution was diluted to 100 c.c., the iron precipitated by powdered $CaCO_3$ or CaO, and the solution filtered. To the filtrate one or two drops of hydrochloric acid were added to remove any turbidity due to calcium carbonate. The clear solution was then poured into a standard colorimetric flask or tube and compared with standard colours. For the series of standard colours a solution of cobalt chloride was used. To prepare the cobalt chloride, a weighed quantity of cobalt nitrate was calcined, and the oxide obtained dissolved in concentrated hydrochloric acid. After the excess acid was removed, the cobalt chloride was dissolved and diluted to give solutions of the desired strength. Standard solutions containing from 0.25 to 5.0 per cent. cobalt oxide were prepared, the different solutions varying by 0.25 per cent. It was possible to determine the cobalt in New Caledonia ores colorimetrically to within 0.25 per cent.

Care must be taken in the preparation of colorimetric solutions to add a small quantity of nickel chloride (about one-third the contained cobalt chloride), for account must be taken of the nickel which the asbolite contains. The amount usually varies between one-half to one-third of the cobalt. Green nickel chlorides decrease a little the rose colouration of cobalt chloride, hence the addition of nickel chloride to the standards.

Electrolytic Determination of Cobalt and Nickel

In Oxidized Ores

The asbolite of New Caledonia contains silica, alumina, chromium, iron, manganese, nickel, and cobalt.

Thirty grams of finely pulverized mineral were treated with concentrated hydrochloric acid until decomposition was complete. In case the mineral was not completely decomposed, the hydrochloric acid solution was allowed to settle, and the clear liquid decanted through a filter. The residue was then heated with a little hydrochloric acid and a small quantity of nitric acid. After removing the excess acid, the solution was diluted and filtered. The residue was washed several times by decantation and finally it was brought into a filter and washed well with boiling water. The last portions filtered should be free from iron, the filtrate being tested by potassium ferrocyanide or sulphocyanide. The filtrates were combined and diluted to 900 c.c.

The residue contained the silica, silicates of alumina, chromite, etc.

To 150 c.c. corresponding to 5 grams of ore, a little sulphuric acid was added and the solution boiled. If any nitric acid was present the solution was evaporated to sulphuric fumes. If the evaporation was necessary, the solution was afterwards diluted to 100 c.c. In either case the iron was reduced by zinc or cadmium shavings, and titrated with standard potassium permanganate. Before titrating it was customary to test for any unreduced iron with potassium ferrocyanide.

From another 150 c.c., the iron, aluminium, and chromium were precipitated. The greater part of the acid was neutralized by sodium carbonate and then a quantity of ammonium chloride was added, followed by additions of barium or

calcium carbonate. The solution was allowed to stand, with frequent stirring, to permit the oxide of chromium to be completely decomposed. After filtering, the precipitate was washed until the wash water did not show a precipitate on the addition of ammonium sulphide. The precipitate was dissolved in hydrochloric acid. From the diluted solution the iron, aluminium, and chromium hydroxides were precipitated by ammonia after the addition of several grams of ammonium chloride. This precipitation is repeated to remove any traces of barium or calcium carbonates.

The precipitate was dried and calcined. By subtracting the weight of iron found previously, the weight of the combined aluminium and chromium oxides was obtained. The precipitate was fused with sodium peroxide and the chromium determined by acidifying the sodium chromate solution, adding a standard ferrous sulphate solution and titrating with permanganate. The alumina was determined by difference.

From the 600 c.c. of solution, the iron, aluminium, and chromium were precipitated by calcium carbonate. After filtering and washing the precipitate, the solution was divided into two parts for the separation of manganese, nickel, and cobalt.

To one-half of the filtrate, which contained the manganese, nickel, and cobalt in 10 grams of ore, sodium carbonate was added in excess, then acetic acid to dissolve the precipitate. Thirty to fifty c.c. of sodium acetate were added to the solution which was afterwards saturated with hydrogen sulphide; the solution being kept at 70°C. The precipitated sulphides of cobalt and nickel were removed by filtering and washed. The filtrate was tested for unprecipitated cobalt and nickel by additions of small quantities of ammonium sulphide which gives a black precipitate with cobalt and nickel salts. Ammonium sulphide was added to the filtrate to precipitate manganese sulphide, a flesh-coloured precipitate. The manganese sulphide was dissolved in hydrochloric acid and the manganese determined as manganese dioxide.

The precipitate of cobalt and nickel sulphides was dissolved in aqua regia and evaporated to dryness. A few c.c. of sulphuric acid were added and the solution heated to remove any volatile acids and destroy any organic matter. The solution of nickel and cobalt sulphates was diluted, neutralized with ammonia, and electrolyzed in a slightly acid solution.

To separate the cobalt and nickel, the metals were dissolved in nitric acid which was removed by evaporation and additions of hydrochloric acid. The almost neutral hydrochloric acid solution was saturated with chlorine gas or bromine, then an excess of calcium or barium carbonate was added. The solution was diluted and allowed to stand.

The cobalt hydrate was precipitated while the nickel remained in solution. Instead of chlorine or bromine, solutions of sodium hypochlorite or hypobromite may be used.

Another method (Rose's method) to separate the cobalt and nickel was to precipitate in a cold neutral solution, the cobalt hydrate by additions of barium or calcium carbonates in the presence of bromine water or chlorine gas. The

use of barium carbonate and bromine was preferred. If the solution became acid, thus delaying and even stopping the precipitation, carbonate was added, the CO_2 expelled, and the solution cooled before adding the bromine water.

Zinc acts like carbonic acid, the smallest quantity retarding the precipitation. The composition of the precipitated black oxide was determined by dissolving in a mixture of HCl, adding potassium iodide and determining the iodine set free.

The above outline of the method of analyzing cobalt ores of New Caledonia was given by Beltzer.[1]

In Arsenical Ores

To 0.5 or 1.0 grams of ore add 10 c.c. of hydrochloric and 5 c.c. of nitric acid. After the action has ceased, add 20 c.c. of (1:1) sulphuric acid, evaporate to sulphuric fumes, and fume for five minutes. In most cases the treatment with hydrochloric and nitric acid may be omitted. To the cool sulphuric acid solution add 10 c.c. of cold water, then 15 c.c. of hydrochloric acid, sp. gr. 1.19 and heat on the hot-plate. Evaporate gently to fumes, then add 5 c.c. of nitric acid and the solution is again heated to fumes. After this operation there should be about 5 c.c. of H_2SO_4 present. About 90 per cent. of the arsenic is volatilized by this treatment.[2] The remainder of the arsenic and any copper are precipitated by H_2S from a hot solution containing 10 c.c. of hydrochloric acid in 100 c.c. of solution. The arsenic sulphide should be completely precipitated and coagulated in five to ten minutes. The solution is filtered using a 15 cm. No. 1 F. Swedish filter paper and the precipitate washed with hot H_2S water. The filtrate may be tested for unprecipitated arsenic by passing H_2S gas through the second time.

The clear filtrate is boiled to expel any H_2S, then 5 c.c. of hydrogen peroxide is added to oxidize the iron. Ammonia is added in excess to precipitate the iron. There is usually a sufficient quantity of ammonium salts present to prevent the precipitation of the cobalt and nickel. After the addition of ammonia, the solution is boiled, and the precipitate allowed to settle, filtered, and washed with hot water. As there is a tendency for the iron precipitate to retain some cobalt and nickel, the precipitate is dissolved in hot (1:4) H_2SO_4, diluted to 200 to 300 c.c., oxidized with hydrogen peroxide, reprecipitated with ammonia and treated as above. The combined filtrates are evaporated to 250 c.c. and electrolyzed. About 40 to 50 c.c. of ammonia should be present in the electrolyte. The addition of 0.5 grams of sodium sulphite before electrolyzing gives a better deposit. For each assay a current of 0.25 amperes running overnight is used with the ordinary stationary platinum electrodes. The best results are usually obtained when there is not more than 0.15 grams of metal on the cathode. With revolving anodes a much shorter time is required.

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[1] Beltzer, La Chimie Industrielle Moderne, 1911.

[2] The writer is indebted to W. L. Rigg, chief chemist of the Deloro Smelting and Refining Company, for the outline of the above method of removing most of the arsenic by volatilization. The volatilization of arsenic chloride is not new, but the writer is advised that T. Melvor, a former chemist at Deloro, was the first to apply the method in the assays for cobalt and nickel.

When the cobalt-nickel solutions contain a large percentage of iron, it is advisable to precipitate cold and afterwards boil the solution. When using a revolving anode, it is not necessary to remove the iron before plating unless present in large quantity.

To test for any cobalt and nickel not deposited, remove a few c.c. of the electrolyte and add a few drops of ammonium sulphide. The formation of a black precipitate shows the presence of cobalt or nickel. The electrolyte may also be tested by removing a few c.c. and adding a few c.c. of dimethylgloxime. Ammonium salts give a yellow colour, cobalt a brown colour, while nickel gives a red precipitate. The last of the nickel appears to be deposited after the cobalt.

After the deposition is complete the electrodes are washed and dried with alcohol and weighed.

The cobalt and nickel is removed from the electrode by placing it in a beaker containing about 7 c.c. of hot nitric acid. The electrodes are allowed to remain in the acid for 10 minutes, any undissolved metal being removed by tilting the beaker and turning the electrode in the acid. The electrode is washed with hot water, and the solution is evaporated to about 1 c.c. or less. Dilute to 10 c.c., neutralize with caustic potash and add sufficient hydrochloric acid from a pipette to dissolve any precipitate and four drops in excess. Then dilute to 50 to 150 c.c., depending on the quantity of nickel, (the larger volume with larger amounts of nickel), and boil the solution. To the hot solution add a sufficient quantity of a 1 per cent. alcoholic solution of dimethylglyoxime to combine with the nickel and cobalt. Nickel requires 5 and cobalt 1.7 times its weight of dimethylgloxime. A few c.c. of the reagent in excess is necessary. When the solution is made slightly alkaline with ammonia a red precipitate of the nickel salt of dimethylglyoxime is formed. An excess of ammonia should be avoided, four drops are usually sufficient. After allowing the precipitate to stand for 30 minutes, filter into a weighed Gooch crucible. The precipitate is washed with hot water, dried at 105°C., and weighed. The weight of the precipitate multiplied by 0.2031 gives the weight of nickel. The weight of cobalt is found by difference. The dimethylglyoxime method of precipitating nickel is especially adapted for determining small amounts of nickel in the presence of large amounts of cobalt. It is satisfactory also when the nickel is high, but the quantity of solution taken should be such that there will not be more than 0.05 grams of nickel present.

The action of dimethylglyoxime on the nickel salt is as follows:

$$2\begin{array}{l}CH_3—C{=}NOH\\ \\ CH_3—C{=}NOH\end{array} + NiCl_2 + 2NH_3 = 2NH_4Cl + (C_8H_{14}N_4O_4)Ni.$$

According to L. Tschugaeff,[1] who first proposed this qualitative test, the presence of one part of nickel can be detected in the presence of 400,000 parts of water. The reaction is not influenced by the presence of ten times as much cobalt. When a larger proportion of cobalt is present the following procedure is adopted to detect traces of nickel in cobalt salts. Add strong ammonia to the solution of the cobalt salt until a clear solution is obtained, then add a few cubic centimetres of hydrogen peroxide and boil the solution a few minutes to decompose

[1] Berichte der Deutschen chemischen Gesellschaft, 1905, p. 2520.

the excess of this reagent. Then add the dimethylglyoxime and again bring the solution to a boil. A very small quantity of nickel causes a red scum to form and the sides of the beaker become coated with a film of red crystals. With smaller amounts of nickel the colour is best observed upon the filter through which the solution is poured and the precipitate being washed with hot water.

The above reaction is the most sensitive test known for detecting nickel in the presence of cobalt.

Separation of Cobalt from Nickel by Nitroso-β-Naphthol

Nickel and cobalt may also be separated by the use of Nitroso-β-Naphthol. This separation depends on the solubility of the nickel compound in hydrochloric acid, while the cobalt compound is insoluble.

To proceed with this method the metals are removed from the electrodes as above, 5 c.c. of sulphuric acid added, and the solution evaporated to sulphuric fumes. Cool, dilute and add 5 c.c. of concentrated hydrochloric acid. A freshly prepared hot solution of nitroso-β-naphthol in 50 per cent. acetic acid solution is added to the cobalt-nickel solution as long as a precipitate continues to form. The precipitate is allowed to settle and the solution tested for any cobalt. The solution is filtered, the precipitate washed, first with cold water, then with warm 12 per cent. hydrochloric acid to remove any nickel. Finally wash with hot water until free from acid. The precipitate is dried and heated strongly to convert the cobalt compound to oxide. After the carbon of the filter paper is all consumed, the cobalt is reduced to metal by heating in a current of hydrogen.

The disadvantages of the nitroso-β-naphthol method are, first, the precipitate cannot be converted to oxide and weighed because of the variable composition of the oxide, and second, the operation of reducing the oxide to metal requires more time and attention than the dimethylglyoxime method.

Separation of Cobalt and Nickel by Potassium Nitrite

After dissolving the cobalt and nickel in nitric acid, the solution is evaporated to a thick syrup. From 5 to 10 c.c. of water is added, and the solution neutralized by potassium hydrate. Any precipitate is dissolved in acetic acid, usually adding 8 c.c. of 1:1 acid in excess. The cobalt is precipitated as yellow tri-potassic-cobaltic nitrite by the addition of a 50 per cent. solution of potassium nitrite, the amount depending on the percentage of cobalt present. An excess of potassium nitrite is required, but usually 10 to 15 grams should be present in each assay. The solution is allowed to stand in a warm place for 15 hours, when the precipitate should have settled to the bottom of the beaker. The solution may be tested for unprecipitated cobalt by removing a portion, adding more nitrite, and allowing the solution to stand for an hour.

The solution is filtered and the precipitate washed with a 5 per cent. solution of potassium nitrite acidified with acetic acid, or with a 10 per cent. solution of potassium acetate, until the precipitate is free from nickel. The filter is removed from the funnel and spread on the inside of the beaker in which the precipitation was made. Most of the precipitate may be removed by a stream of hot water, while any remaining on the paper is dissolved by hot dilute sulphuric acid. The cobalt solution is evaporated to sulphuric fumes, cooled, diluted, made ammoniacal, and electrolyzed. The nickel is obtained by difference.

Separation of Zinc from Cobalt and Nickel

The usual method given to separate zinc from cobalt and nickel is to precipitate the two latter metals by hydrogen sulphide in a neutral, acetate, or formic acid solution.[1] Funk suggests neutralizing the solution with sodium carbonate and formic acid, and adding sodium formate equal to approximately three times the weight of the zinc. The quantity of cobalt and nickel present also has an effect on the purity of the precipitate and the completeness of the precipitation.

Zinc may be separated from cobalt by adding to a neutral solution potassium cyanide until any precipitate which forms is redissolved, then 10 c.c. of a 10 per cent. solution of potassium sulphide. After standing for 1-2 hours the zinc sulphide may be removed by filtration.

It is also possible to separate cobalt and nickel from zinc by electrolysis at 2.1-2.2 volts. With higher voltages the zinc is deposited.

Determination of Cobalt and Nickel in Cobalt Metal[2]

One gram of drillings contained in a 150 c.c. conical flask provided with a trap (made of a calcium chloride tube) is treated with 20 c.c. of hydrochloric acid, sp. gr. 1.12. A gentle heat is applied until all action ceases. One c.c. of nitric acid sp. gr. 1.4 is added to dissolve any remaining metallic residue. As soon as the action of the nitric acid is complete, the trap is rinsed, removed, and the solution evaporated to a syrup. The contents of the flask are taken up with 30 c.c. of water and filtered.

The siliceous residue on the filter is washed with water acidulated with a few drops of hydrochloric acid, incinerated, and fused with five times its weight of potassium pyrosulphate. The fusion is dissolved in a little water, and added to the main filtrate. The slightly acid solution of the metal is warmed and saturated with hydrogen sulphide. The sulphides of arsenic, copper, etc., are removed by filtration, thoroughly washed with acidulated hydrogen sulphide water (1 c.c. HCl: $100H_2O$) and the filtrate caught in a 350-c.c. casserole.

To expel the H_2S, the contents of the casserole are evaporated to a small volume. The iron is oxidized with a few drops of bromine, 0.2 grams of ammonium chloride added, and the evaporation continued to dryness at water-bath temperature.

The dry chlorides are dissolved in a little water, 0.1 gram of ammonium formate added, and the whole diluted to 50 c.c. The solution is heated until a precipitate of basic formate of iron separates. Very dilute ammonia is added until the solution is only slightly acid. After further heating for a few minutes, the precipitate of basic iron formate is allowed to settle, filtered, and washed with a hot dilute (0.1 per cent.) solution of ammonium formate.

The washed iron precipitate is dissolved off the filter with hot dilute (1:5) hydrochloric acid, the filtrate being caught in the casserole in which the iron precipitation was made. The solution of the iron precipitate is neutralized with ammonia, ammonium formate added, and the iron precipitation repeated in a volume of about 50 c.c. The precipitate is filtered and washed with the hot dilute ammonium formate solution as before.

The combined filtrates from the two iron separations are evaporated with

[1] These methods are summarized by Funk, Zeitschr. anal. Chemie, Vol. 46, 1907, pp. 93-106.

[2] Knittel, Can. Min. Jour., Vol. 36, 1915, p. 597.

the addition of 8 c.c. of concentrated sulphuric acid until fumes of sulphuric acid are copiously evolved.

The sulphates are dissolved in water and transferred to a 180 c.c. tall beaker, keeping the volume of the solution about 50 c.c. Sixty c.c. of ammonia, sp. gr. 0.9 is gradually added to the solution in the beaker (kept cool in running water) followed by 10 c.c. of 20 per cent. ammonium bisulphite solution.

The cobalt and nickel are deposited together with a current of 2.5 amperes. When the solution is colourless, the cover glass and the sides of the beaker are rinsed with water, and the current, reduced to 0.5 amperes, is allowed to pass until a few c.c. of electrolyte tested with potassium sulphocarbonate show that the cobalt and nickel are completely deposited. The cathode is removed with the usual precautions, dried, and the deposited cobalt and nickel weighed.

The cobalt and nickel are dissolved from the cathode with 30 c.c. of nitric acid (1:3), the cathode rinsed, removed, and the solution of the metals boiled to expel nitrous fumes. The solution is diluted to 500 c.c., neutralized with ammonia, made faintly acid with nitric acid, heated to about 50 to 60°C. and the nickel precipitated with a 1 per cent. alcoholic solution of dimethylglyoxime, followed by 10 c.c. of a 20 per cent. ammonium acetate solution.

The precipitate is allowed to stand for four hours, filtered on asbestos, washed twice with hot water, re-dissolved, and the precipitation repeated in a volume of 200 c.c.

After standing for an hour in a warm place, the nickel precipitate is filtered into a Gooch crucible, washed with hot water, and dried at 130 to 140°C. for forty-five minutes. The weight of the precipitate multiplied by 0.20316 gives the nickel. The amount of cobalt is found by difference.

Notes and Precautions.—Cobalt metal usually contains from 98 to 98.5 per cent. cobalt plus nickel. For this reason the amount of 0.2 to 0.3 grams of material recommended by some for the determination of the cobalt and nickel seems scarcely sufficient, as the weighing errors involved would appreciably affect the results. The use of large quantities of acids for solution and oxidation is to be condemned, as the removal of the excess consumes time and increases the chances of mechanical loss.

The separation of iron as basic formate is preferred on account of the ease with which it can be washed, and the formates are completely decomposed on evaporation with sulphuric acid.

The presence of acetates in the electrolyte seems to retard the complete deposition of the last traces of nickel. In one instance on electrolyzing a solution from metal containing 97.5 per cent. of cobalt and 0.8 per cent. of nickel, in the presence of acetates one milligram of nickel was found in the electrolyte 30 minutes after complete deposition of the cobalt. The volume of the electrolyte should be kept within the limit specified above, as the complete deposition of the metals from dilute solutions is unnecessarily prolonged.

It has been found that the amount of cobalt and nickel remaining in the electrolyte after electrolysis is less than 0.01 per cent. on a one gram sample.

The cathodes used are of the perforated type with an effective surface of 90 square centimetres. The anodes are spirals made of 0.04 inch wire, 0.6 inch diameter, and have about 6 turns.

Dry Assay for Nickel and Cobalt [1]

In this assay advantage is taken (1) of the facility with which nickel and cobalt may be concentrated in combination with arsenic to form a speiss; (2) of the order of oxidation of the metals which the speiss may contain, viz., iron, cobalt, nickel, and copper, and the colours they impart to borax. They are removed in the order named. Iron gives a brownish colour to borax, cobalt a blue, nickel a sherry-brown, and copper a blue. Hence, on scorifying the speiss with borax, the colour imparted by the oxide produced indicates the metal being removed. By careful and frequent examination of the colour resulting and the renewal of the borax it is possible to find the point at which first the iron and then the cobalt and nickel are removed. A greenish tint is imparted to the borax at the moment the cobalt begins to scorify, succeeded by a full blue (with fresh borax), followed by a greenish tint when the nickel commences to pass out. This changes to the full sherry-brown, and is followed by a greenish tint when copper commences to oxidize.

Careful examination and much care are necessary to obtain even fair results. By weighing the button at the various stages, the proportion of its constituents may be determined. If copper be present, 1 gram of gold is added to the button after the removal of the cobalt.

Assay of Ores and Speiss.

From 5 to 25 grams of the ore are finely powdered and passed through an 80-mesh sieve and calcined "sweet." At the end of the roasting some finely ground anthracite must be added, and the calcination continued till the carbon is burnt away, thus reducing the sulphates and arsenates formed in the earlier stages.

The roasted mass is mixed with 0.2 to 0.5 times its weight of arsenic, an equal weight of carbonate of soda, 5 grams of argol, and 2 to 4 grams of borax, melted in a crucible at a moderate temperature, and poured. If iron be absent, 0.5 grams of pure iron filings must be added before fusion.

When cold, the button is detached from the slag and weighed. It should be metallic in appearance, and have a smooth grey surface. Portions weighing 1 gram should be taken for the subsequent scorification.

The scorification with borax is conducted in small shallow dishes ¾ inch in diameter inside and ⅛ inch deep. These may be made of finely-sifted clay and ground pots. The clay should be stiff, and as much pressure as possible used in shaping them. The die may be made of boxwood, and provided with a gun-metal or iron ring. The dishes should be dried carefully and heated to dull redness in a muffle before use.

While preparing the speiss, a small muffle should be made as hot as possible, as the success of the operation depends largely on the temperature. The back of the muffle should be white-hot. Place a number of the small dishes in the muffle. Have at hand some ground borax glass, and a vessel of cold water. Place about a gram (rather less than more) of borax in one of the dishes as far from the front as can be seen. It is convenient to wrap the borax in tissue paper and drop in the speiss, also wrapped in tissue paper.

The muffle should be hot enough to melt the speiss immediately, or the order of oxidation will not be preserved. The borax should not be sufficient to cover the speiss when melted. For a moment the surface is dull, but almost instantly brightens and scorifies, very much like the brightening stage in the cupellation of silver. In a few moments remove the dish and contents, and immediately place the bottom of it in water to cool, and as soon as the bead is solid, submerge it in the water.

If iron only has passed off, the brownish-yellow tint due to that metal will only be observed, but if the smallest amount of cobalt has been removed the slag will be greenish or, if a larger quantity, blue. The correct stage has been reached when a faint green tinge is visible in the slags near the edge and round the button. If this be not observed, the operation is repeated till the point is reached. If it is past, the scorification is re-started with a fresh portion of speiss.

The speiss now only contains cobalt, nickel, and copper. It is weighed, and the operation repeated with every precaution till the cobalt is removed. Less borax is necessary as the bead is reduced in size, and a green cap of arsenate appears when the nickel commences to oxidize, as well as the greenish tinge in the slag near the bottom. The attainment of this point is marked also by the motion of the button momentarily ceasing. The process needs careful watching. The dish is withdrawn, and quenched carefully as before. If, on examination, it is doubtful whether the nickel has commenced to scorify, it is best to weigh the prill and return it to a scorifier with fresh borax, and examine immediately it is melted. The dense blue of the cobalt will not then interfere, and the brownish colour of the nickel (and the green cap) will be apparent. The prill is weighed. If copper were present in the speiss, the prill will now consist of nickel and copper arsenides. If much nickel is present the scorification may be continued in the same manner, but it is better to add 1 gram of pure gold, and continue the scorification so long as nickel continues to be removed. The resulting

[1] Assaying and Metallurgical Analysis, pp. 193-195, Rhead and Sexton; Longmans, Green and Company, 1911.

bead consists of the added gold and copper. It is weighed, and the increase in weight of the gold bead gives the copper. Confirmatory results may be obtained by cupelling the gold-copper bead with 34 times its weight of lead, when the gold only will be left, the loss of weight being copper.

In the above remarks it has been assumed that cobalt is present. If it is absent, it is difficult to ascertain the point at which iron is removed and nickel commences to pass out. Further, in assaying an unknown speiss, which may contain nickel and iron only, the green arsenate of nickel which forms on the surface and under the bead must not be confounded with the green tinge indicated above.

Modified Method.

In order to avoid the difficulty caused by the copper, it is sometimes removed before forming the speiss.

The sample of ore is digested with aqua regia till completely decomposed, hydrochloric acid added, and the nitric acid expelled by evaporation. Water is then added, and the liquor saturated with sulphuretted hydrogen, which precipitates the copper, etc. The liquid is filtered, and the residue washed with water containing sulphuretted hydrogen.

The filtrate is then boiled till sulphuretted hydrogen is completely expelled, oxidized by adding a few drops of nitric acid to the boiling solution and neutralized. To the neutral solution barium carbonate and bromine water are added in excess and well shaken. After boiling, the solution is filtered, and the precipitate washed, dried, and ignited. This precipitate, which contains the whole of the iron, cobalt, and nickel, is converted into a speiss as before, but without roasting.

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CHAPTER IV

THE USES OF COBALT

Cobalt Oxide

Cobalt is used chiefly in the form of oxide in the enamel, porcelain, and glass industries, but within the last few years new uses have been found for the metal which is at present produced in considerable quantity. Cobalt metal is used chiefly in the manufacture of stellite, a cobalt-chromium alloy, used as a cutting tool. The metal is added to some high-speed steels to give improved cutting qualities. It is also used in cobalt plating.

Cobalt oxide and its compounds are used as pigments or colouring agents. It is said that when cobalt oxide is present in the ratio of 1:20,000, it imparts a bluish tinge to clear glass or porcelain. The oxide is black or gray, but when fused with borax or silica it possesses a brilliant blue colour. Cobalt oxide is also used in small proportions to produce white enamels, since any yellow colour due to iron oxide is neutralized by the complementary cobalt blue, producing a pure white. Also by the addition of cobalt oxide, copper oxide, pyrolusite, and even iron oxide, to certain raw mixtures or waste enamels, a beautiful black enamel is obtained. The compounds of cobalt, for example, silicate, aluminate, phosphate, arsenate, and nitrite are used instead of the oxide, because they give better and more uniform colouring. The following table gives a list of the customary brands of cobalt compounds with their cobalt content:—

Brand.	Special Designation.	Chemical Formula.	Percentage Cobalt Content.
F F Ko	Finest cobalt oxide (superior oxide)	CoO	78* per cent.
G K O	Grey cobalt oxide, Ia	CoO	76* "
F K O	Grey cobalt oxide	CoO	75* "
R K O	Black cobalt oxide, Ia	Co_2O_3	70* "
S K O	Black cobalt oxide	Co_3O_4	66* "
A K O	Cobalt arsenate	$Co_3As_2O_8.8H_2O$	29 "
K O H	Cobalt carbonate	$CoCO_3$	50 "
P K O	Cobalt phosphate	$Co_3(PO_4)_2.8H_2O$	34 "

* Theoretically CoO, Co_2O_3, and Co_3O_4 contain 78.8, 71.1, and 73.4 per cent cobalt, respectively.

The history of the value of cobalt compounds as colouring agents dates back to pre-historic times. However, it may be stated that it was not until the discovery of the silver-cobalt deposits at Schneeberg in 1470, that cobalt was used to any great extent. The preparation of cobalt compounds must have been carried on in a small way because about the year 1790, there were 25 works engaged in the industry, most of which were located in Saxony, and the total production of these works was not more than 300 tons of cobalt annually, which was mostly in the form of smalt. The smalt which contained approximately 6 per cent. cobalt was sold in Venice in 1520 at about 16 cents a pound. There were also a few refineries in Holland which supplied the Irish linen trade almost entirely, as well as a large amount to the linen industries at home. It was also used in Holland in the manufacture of litmus. A complete description of the early history of the cobalt industry in Saxony, is given by Mickle in the Report of the Bureau of Mines of Ontario, vol. XIX, 1913, Pt. II, pp. 234-251.

At present the ceramic industry is carried on chiefly in the United States, Germany, France, and Austria-Hungary. In Germany and Austria-Hungary it gives employment to 50,000 people.

Smalt is used now only in a few enamel works. It is a blue compound which owes its colour to the presence of cobalt silicate. As formerly prepared it contained appreciable quantities of impurities. The oxides of cobalt are preferred to smalt because of their purity, uniformity, and lower cost.

The arsenate is prepared by adding sodium arsenate to a cobalt nitrate solution.

Cobaltous carbonate is obtained by adding soda or potash to a solution of a cobalt salt. The rose coloured precipitate which forms is a basic carbonate, of the formula $CoCO_3+Co(OH)_2$.

Cobalt phosphate is prepared by adding sodium phosphate to a cobalt acetate solution. The precipitate is violet in colour and has the formula $Co_3(PO_4)_2$.

The aluminate is formed by adding sodium carbonate to a mixture of cobalt nitrate and alum. The cobalt and aluminium hydroxides may be precipitated separately and afterwards mixed. The mixed hydroxides are washed, dried, and heated at a red heat. The blue cobalt aluminate which forms is ground and dried.

The colour produced by the aluminate, phosphate, or arsenate has various names, for example, cobalt blue, cobalt ultramarine, king's blue, Thenard's blue, or azure blue. Thenard's blue corresponds to cobalt aluminate. Coeruleum, coeline, or blue celeste, is a blue colour showing a slightly greenish tint. It contains oxide of tin and sometimes calcium sulphate. To prepare such a pigment, sodium stannate is added to a cobalt nitrate solution. The precipitate is washed and heated. Another method to prepare blue celeste is to heat cobalt sulphate, tin oxide, and precipitated silica or chalk.

Mazarine blue[1] is commonly employed as a band on the edges of plates. The colour is prepared by mixing cobalt oxide, with tin oxide, sand, and calcium sulphate.

New blue is a pigment varying in colour from a pale greenish blue to a deep turquoise blue. It is largely used for enamels, and consists of aluminates of cobalt and chromium produced by the action of alum on carbonates and hydrates of cobalt and chromium.

Cobalt green or Rinmann's green is formed by substituting zinc oxide for alumina in cobalt aluminate, giving cobalt zincate. This compound may also be formed by mixing the hydroxides or oxides or by adding soda to a cobalt-zinc solution. In either case the oxides must be heated to form the zinc compound. The darker green colours contain the smaller quantities of zinc. A mixture of calcined cobalt carbonate, chromium oxide, and alumina also produces a green pigment.

Cobalt bronze is a cobalt ammonium phosphate compound. It has a violet colour with a bronze-like metallic lustre.

Cobalt yellow, Indian yellow, aureolin, is the precipitate potassium cobaltic nitrite. It is prepared by adding potassium nitrite to a cobalt solution acidified with acetic acid. It is a bright yellow precipitate which because of its purity produces an excellent colour.

[1] Mellor, Clay and Pottery Industries, 1914, p. 71, Lippincott, Philadelphia.

Cobalt brown is formed by calcining a mixture of ammonium sulphate, cobalt sulphate and ferrous sulphate.

In the burning operation of cobalt compounds, it is important that the temperature should not be too high, as a high temperature produces unsatisfactory colours. Of the cobalt compounds the silicate, carbonate and phosphate are the most important.

Cobalt oxide, up to 0.5 per cent., is used in practically all ground enamels as it possesses the property of causing the enamel to adhere better to sheet iron and at the same time neutralizes any yellow colour due to iron oxide. Although numerous investigations have been undertaken to account for this property, no satisfactory explanation has yet been given.

Blue enamels contain on an average 1 per cent. of cobalt, but when a dark blue colour is desired, cobalt may be present up to 3 per cent.

Red and pink cobalt compounds are of scientific rather than technical interest. If cobalt arsenate is strongly heated and then ground it yields a pinkish-red powder. The precipitate obtained from a solution of a cobalt salt with sodium phosphate is pink, changing to violet when heated. Cobalt magnesia pink is obtained from precipitated magnesium carbonate, mixed to a thin paste with cobalt nitrate solution, dried, and heated in crucibles.

Sympathetic inks.—Many of the salts of cobalt are pink and deliquescent. If a weak aqueous solution of one of them, such as the nitrate or chloride, is used as ink, the writing is practically invisible, but if the paper is held near the fire the combined water is driven off and the writing becomes blue and visible. It will afterwards absorb water from the atmosphere and again disappear.

A few experiments have been made to test the action of cobalt nitrate as an addition agent in flotation but it did not show any advantages.[1]

Uses of Metallic Cobalt

Metallic cobalt is used chiefly in the preparation of alloys and high-speed alloy steels. The cobalt-chromium alloys are the most important. These alloys possess extreme hardness and are being used extensively to replace high-speed steels as cutting tools. The trade name of the cobalt chromium alloys is "stellite." Stellite is not a steel, and its properties are altogether different from those of steel. It cannot be hardened or tempered, nor does it lose any of its hardness even when the edge of the tool is at a red heat. Tests have shown that a stellite cutting tool permits more rapid cutting than when the ordinary high-speed steel is used.

The cobalt-chromium alloys are hard, but the hardness is increased by additions of tungsten and molybdenum. As the hardness increases the brittleness also increases. The addition of iron softens the alloy.

Stellite alloys possess a bright surface, and are very resistant to oxidation. They remain unaltered in the atmosphere, and are not attacked by the ordinary acids. The colour of the alloys, when polished, lies between that of steel and silver.

[1] Metallurgical and Chemical Engineering, Vol. XVIII, 1918, p. 76.

The tools are made by casting the alloy into bars of the desired shape and size. These are afterwards ground to a cutting edge on an emery or carborundum wheel.

Two grades of stellite tools are made, one with moderate hardness and great strength for turning steel, and the other with greater hardness but less strength for turning cast iron. The tool used for cast iron enables a greater amount of work to be accomplished, whereas, if operating at a high speed with the stellite tool for steels, the edge would be immediately destroyed.

Further information on these alloys will be found in the section on alloys.

The use of stellite alloys for cutlery has been suggested but up to the present, it has not been used for this purpose as the demand for the cutting tool has been so great.

Electro-plating with Cobalt

Owing to the success that has attended nickel plating, the question arose as to whether cobalt platings possess any superior qualities to nickel platings. In order to decide this question a number of experiments were undertaken at the School of Mining, Kingston, Canada, for the Mines Branch of the Department of Mines. A report[1] of this investigation has been issued, and in it some interesting conclusions are given. The results of the work were tested and confirmed by disinterested operators.

The advantages claimed for cobalt plating may be summarized as follows:—

1. Cobalt may be plated from four to fifteen times as quickly as nickel.
2. The cobalt plating is harder than the ordinary nickel plating.
3. About one-fourth the weight of cobalt as compared with nickel is required to do the same protective work.

Cobalt may be plated on brass, iron, steel, copper, tin, German silver, lead and Britannia metal.

The composition of the solutions recommended is as follows:—

Solution 1 B.—Cobalt-ammonium-sulphate, $CoSO_4.(NH_4)_2SO_4.6H_2O$—200 grams to the litre of water, which is the equivalent of 145 grams of anhydrous cobalt-ammonium-sulphate, $CoSO_4.(NH_4)_2SO_4$, to the litre of water. Sp. gr.= 1.053 at 15°C.

Solution XIII B:—Cobalt sulphate, $CoSO_4$—312 grams; sodium chloride, $NaCl$—19.6 grams; boric acid—nearly to saturation; water—1,000 c.c. Sp. gr.= 1.25 at 15°C.

Further experiments are being conducted to test the value of cobalt platings.

Kowalke[2] gives an account of a few experiments made to test the suitability of cobalt for use in thermocouples. He states that cobalt should have an important place among thermo-elements since it does not become brittle like nickel, and it gives a high electromotive force.

An amalgam of cobalt is used in dentistry.

[1] Kalmus, Electro-plating with Cobalt: Bulletin No. 334, Department of Mines, Ottawa, 1915. Trans. Am. Electrochemical Society, Vol. XXVII, 1915, pp. 75-130.

[2] Cobalt as an Element for Thermocouples, Trans. Amer. Electrochem. Soc., Vol. XXIX, 1916, pp. 561-568.

A French patent (No. 460,093, July 7, 1913) covers the preparation of cobalt filaments for incandescent electric lamps. The filament is made from a solution of cellulose with zinc chloride, cobalt oxide, and manganese sulphate. It is heated to incandescence for twenty hours and then coated with carbon.

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CHAPTER V

BINARY ALLOYS OF COBALT

Cobalt and Aluminium

The equilibrium diagram of the cobalt aluminium alloys[1] is shown in Figure. 1. The liquidus curve[2] consists of 4 branches, viz.: AB, BC, CDE, and EF. The points A and F, shown at 658° and 1492°C., correspond to the melting points of aluminium and cobalt respectively. The point E at 1375°C. and 90.5 per cent. cobalt is a minimum point. Alloys of composition represented by points to the right of E consist when solid of a solid solution of aluminium in cobalt. The point D at 1628°C. and 68.5 per cent. cobalt corresponds to the melting point and composition of the compound CoAl. At C, 1165°C. and 38 per cent. cobalt, there is a reaction between the CoAl crystals and the liquid of composition C to form a new compound Co_2Al_5 containing 46.5 per cent. cobalt. At B, 940°C. and 20 per cent. cobalt, there is a reaction between the previously formed Co_2Al_5 crystals and the liquid of composition B to form the compound Co_3Al_{13}, containing approximately 33.5 per cent. cobalt.

The alloys containing between 100 and 68.5 per cent. cobalt are magnetic, the magnetism decreasing rapidly with increased aluminium content.

Schumeister[3] has studied the mechanical and chemical properties of aluminium cobalt alloys containing from 0 to 20 per cent. cobalt. The tests show that the alloys containing 9 to 12 per cent. cobalt possess the greatest tensile strength. Addition of small quantities of tungsten, 0.8 to 1.2 per cent. raised the tensile strength considerably, while with further additions the strength is lowered. The substitution of molybdenum for tungsten did not show any advantage. The aluminium cobalt alloys were harder, easier to work, more stable and durable in the air than pure aluminium.

Peltery obtained a patent[4] on the addition of silver, gold, cobalt, chromium, iron, manganese, and nickel to aluminium; also the General Electric Company, Berlin, patented a light bearing metal containing aluminium with lead, tin, cobalt, chromium, iron, molybdenum, nickel, and antimony.[5]

The following table gives the results obtained later by Schumeister[6] from additions of cobalt, 0 to 12 per cent., on the tensile strength, elongation, and hardness of aluminium. The fracture of the alloys changes from a coarse to a very fine grain with increased proportion of cobalt. The following table shows the effect of additions of cobalt to aluminium.

[1] Gwyer, Aluminium and Cobalt: Zeitschr. anorg. Chemie, Vol. LVII, 1908, pp. 140-147.

[2] The liquidus or freezing point curve represents the beginning of freezing or solidification of any alloy.

[3] Schumeister, Investigation of the Mechanical and Chemical Properties of Light Cobalt Aluminium Alloys: Metallurgie, Vol. VIII, 1911, pp. 650-655.

[4] German Patent, No. 230,095, Jan. 16th, 1911.

[5] German Patent, No. 257,868, March 20th, 1913.

[6] Schumeister, Investigation of the Binary Aluminium Alloys: Stahl and Eisen, Vol. XXXV, 1915, pp. 873, 874.

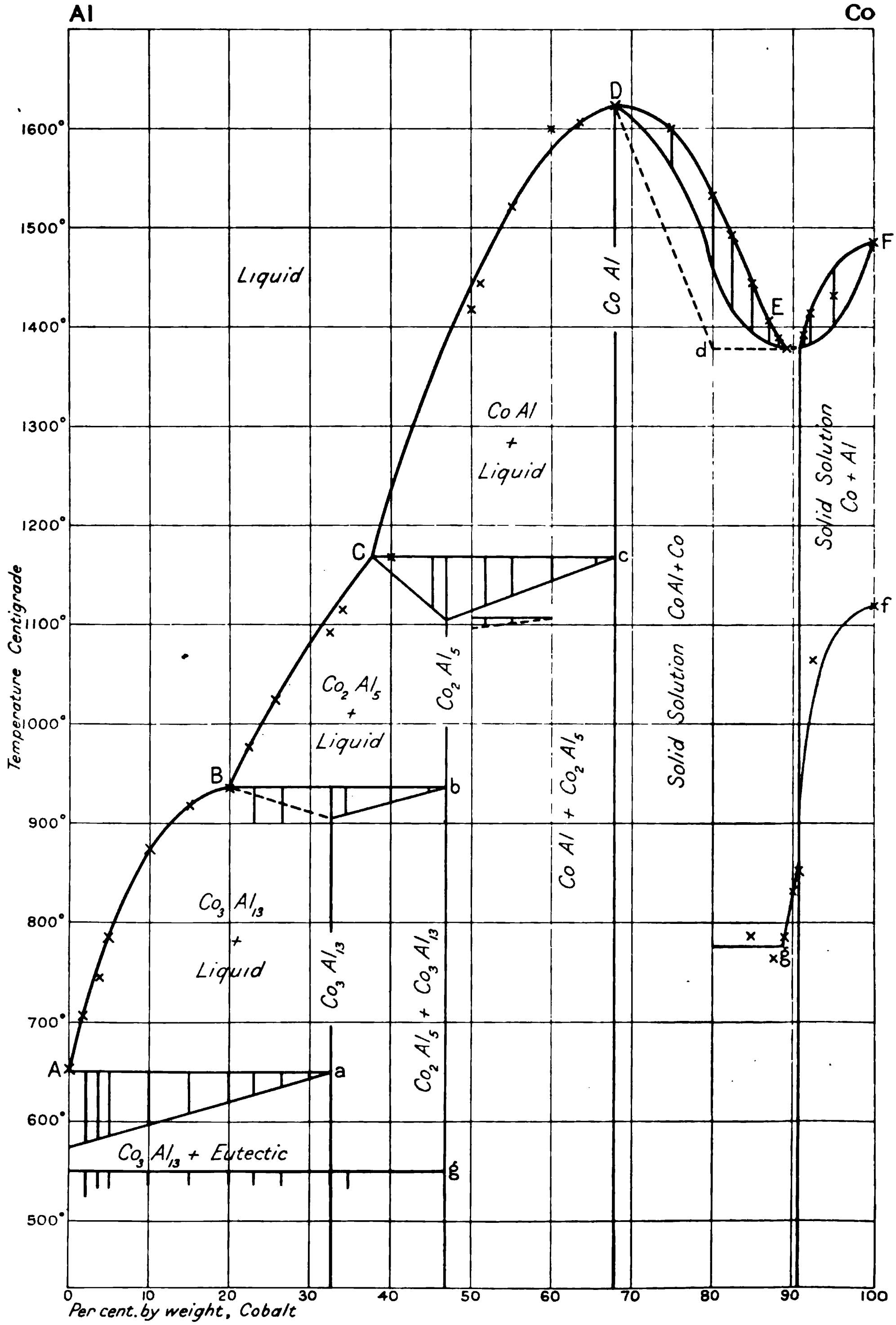

Figure 1.—Equilibrium Diagram of Aluminium-Cobalt Alloys.

Cobalt Content	Tensile strength per sq. m.m.	Elongation per cent.	Hardness
0.0	10.5	34	29
0.6	10.9	35	32
1.6	12.0	28	....
2.3	12.3	25	....
3.5	12.9	21	47
5.5	15.5	18	....
7.5	16.6	14	50
9.4	16.5	11	51
10.5	17.0	11	....
12.0	18.5	6	61

Additional References

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Cobalt and Antimony

The equilibrium diagram[1] of the cobalt antimony alloys is shown in Figure 2. Both metals are soluble in one another in the liquid state, but only to a small extent in the solid. At 1093°C., cobalt retains 12.5 per cent. by weight of antimony in solid solution; the amount, however, decreases with the temperature. There is no evidence of antimony dissolving cobalt in the solid state.

The addition of antimony lowers the melting point of cobalt, A, until the eutectic point E is reached at 1093°C. and 39 per cent. antimony. The liquidus curve shows a maximum C at 1191°C. and 67 per cent. antimony, corresponding to the compound CoSb. At 897.5°C. there is a reaction between the separated crystals CoSb and the liquid D to form a new compound F. The exact composition of the compound F has not yet been definitely determined. From the eutectic point G, at 615°C. and 98.5 per cent. antimony, the liquidus rises to H at 630°C. the melting point of antimony.

The transformation temperature of cobalt at 1159°C. is lowered to 930°C. by addition of antimony up to 12.5 per cent. For all alloys between 12.5 and 67 per cent. Sb, the transformation takes place at constant temperature, viz., 930°C.

Additional References

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[1] Guertler, Metallographie, Vol. I, 1912, pp. 754-756.

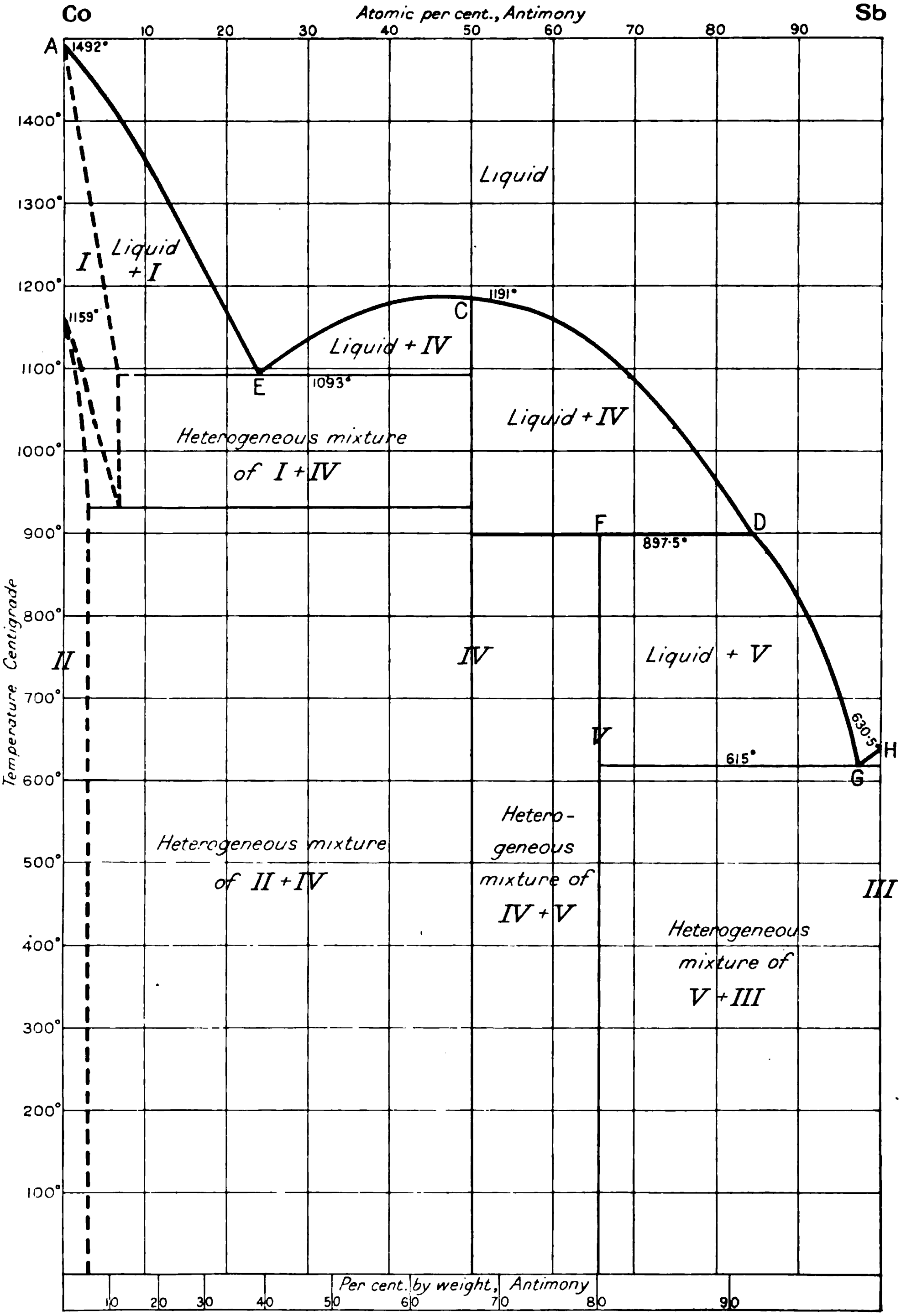

Figure 2.—Equilibrium Diagram of Cobalt-Antimony Alloys.

Cobalt and Arsenic

The cobalt arsenic equilibrium diagram[1] is shown in part in Figure 3. Owing to the volatilization loss of arsenic it has been impossible to investigate concentrations of more than 60 per cent. arsenic.

Cobalt retains about 1 to 2 per cent. arsenic in solid solution. At a temperature of 920°C. and a concentration of 30 per cent. arsenic, there is a eutectic point. With further additions of arsenic, the liquidus curve rises in several successive stages to a maximum at 1175°C. and 57 per cent. arsenic. This maximum corresponds to the compound CoAs. At the temperatures 1014°, 960°, and 930°C., there are three changes in the direction of the liquidus corresponding to the separation of crystals IV, V, VI, of the composition approaching Co_3As_2, Co_2As, and Co_5As_2. Conclusive evidence of the existence of these compounds has as yet not been obtained.

There are also three horizontals in the diagram, at 910°, 830°, and 380°C. The horizontal at 910° between crystals V and III, shows a change in the solid state of crystals IV to crystals VII of similar composition. The horizontal at 830° reaching between crystals I and VI corresponds to a change in the solid crystals VI to IX of the same composition. For compositions containing mixtures of crystals V and VII there appears to be a transformation at 380°, but positive evidence of the exact nature of this change is lacking.

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Action of Heat on Mixtures of Arsenic and Cobalt: Procès verbaux de la société des sciences physiques et naturelles de Bordeaux, 1908, pp. 57-73.

Cobalt and Bismuth

The equilibrium diagram[2] of the cobalt bismuth system is shown in Figure 4. The metals are only partly soluble in the liquid state. At 1390°C. the concentration of the two layers is 92.7 per cent. cobalt and 7.3 per cent. bismuth; and 93 per cent. bismuth and 7 per cent. cobalt. The first addition of bismuth to cobalt lowers the melting point of the latter by approximately 100°C. The addition of cobalt to bismuth lowers the melting point of bismuth approximately 10° to a eutectic point at 96.7 per cent.

Additional References

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[1] Guertler, Metallographie, Vol. I, 1912, pp. 833-836.
[2] Guertler, Metalloghaphie, Vol. I, 1912, pp. 584-586.

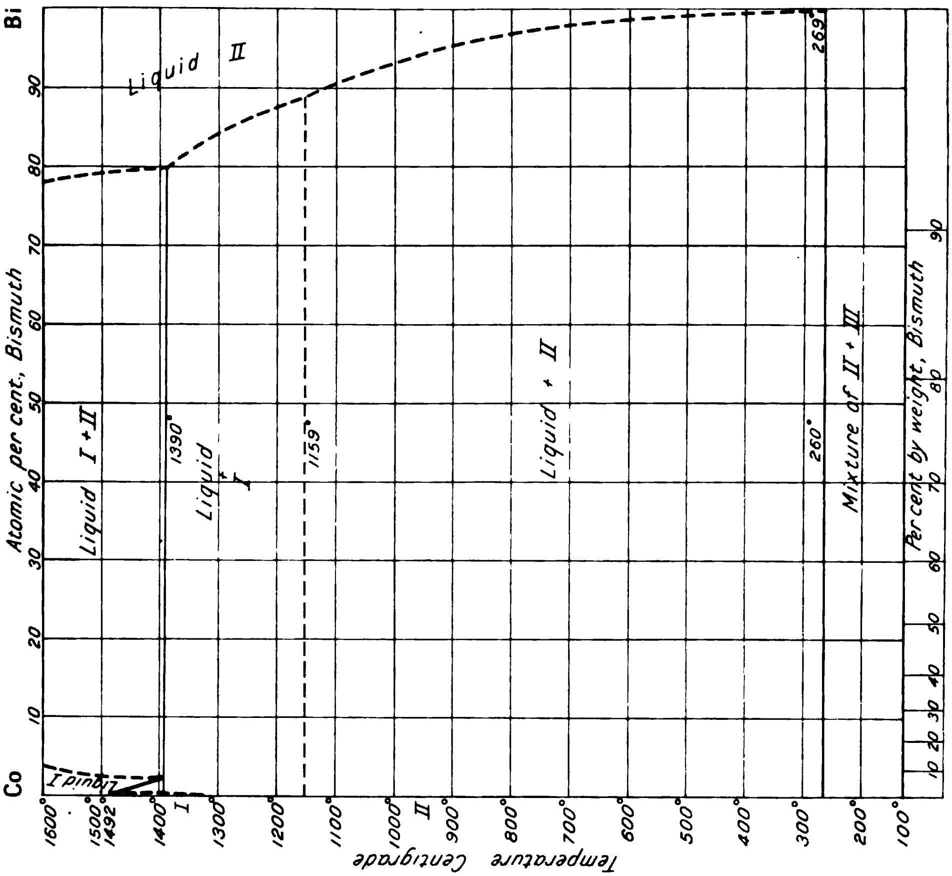

Figure 4.—Equilibrium Diagram of Cobalt-Bismuth Alloys.

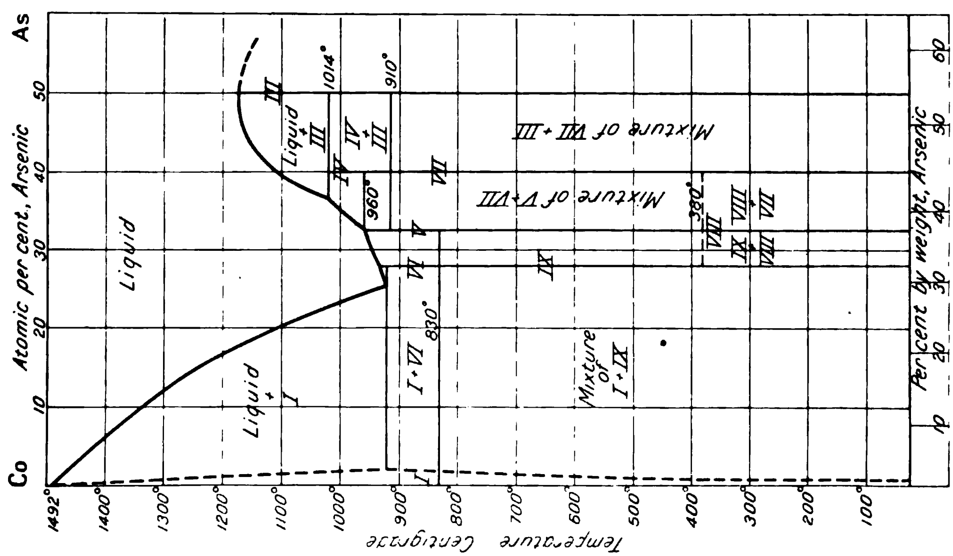

Figure 3.—Equilibrium Diagram of Cobalt-Arsenic Alloys.

Cobalt and Boron

The equilibrium diagram of cobalt and boron alloys or mixtures has not yet been published. However, the compounds Co_2B and CoB_2 have been detected.

The magnetic transformation of Co_2B occurs at 156°C.

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Cobalt and Cadmium

A few experiments on the addition of cobalt to cadmium were made by Lewkonja.[1] In all the tests a distinct eutectic point was observed at 316°C., 6° below the melting point of cadmium. None of the alloys were magnetic. It is evident that there must be either a compound formed, or that a solid solution of cadmium in cobalt must exist, as the transition to *a* cobalt was lowered to below the room temperature.

Additional Reference

Guertler, Metallographie, Vol. I, 1912, p. 487.

Cobalt and Carbon

The equilibrium diagram of the cobalt carbon series has been investigated by Boecker,[2] and later by Ruff and Keilig.[3] The diagram of Ruff and Keilig is shown in Figure 5.

Both diagrams show the existence of a eutectic at 1300°C. and 2.8 to 2.4 per cent. carbon. At the eutectic temperature cobalt retains 0.82 per cent. carbon in solid solution, which separates as graphite on cooling, only 0.3 per cent. being retained at 1000°C. Boecker did not carry the experiments above 1700°C., at which temperature he found the maximum solubility of carbon in cobalt to be 3.9 per cent.

The investigations of Ruff and Keilig were conducted at temperatures up to 2415°C., which is the boiling point of the liquid under 30 m.m. pressure. The boiling point of pure cobalt was found to be 2375°C. under these conditions. The existence of a cobalt carbide has not yet been definitely proved.

Additional References

Keilig, The Cobalt-Carbon System for Temperatures above 1500°C. Dissertation, Königliche Tecknische Hochschule in Danzig, 1915.

Guertler, Metallographie, Vol. 2, 1913, p. 639.

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[1] Lewkonja, Cobalt-Cadmium Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, p. 322.

[2] Boecker, Investigation of the Cobalt-Carbon System: Metallurgie, Vol. IX, 1912, pp. 296-303.

[3] Ruff and Keilig, Cobalt and Carbon: Zeitschr. anorg. Chemie, Vol. LXXXVIII, 1914, pp. 410-423.

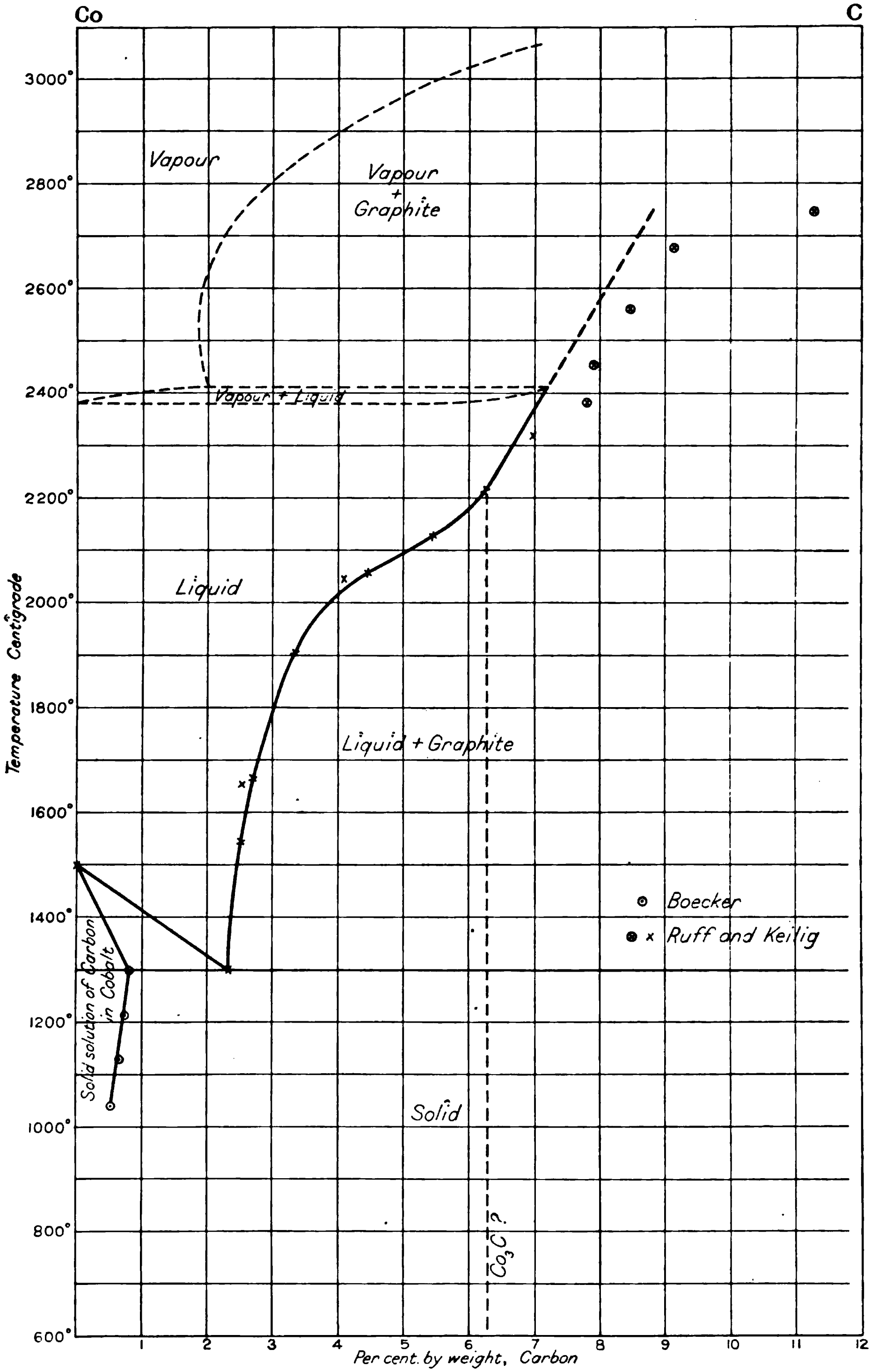

Figure 5.—Equilibrium Diagram of Cobalt-Carbon Alloys.

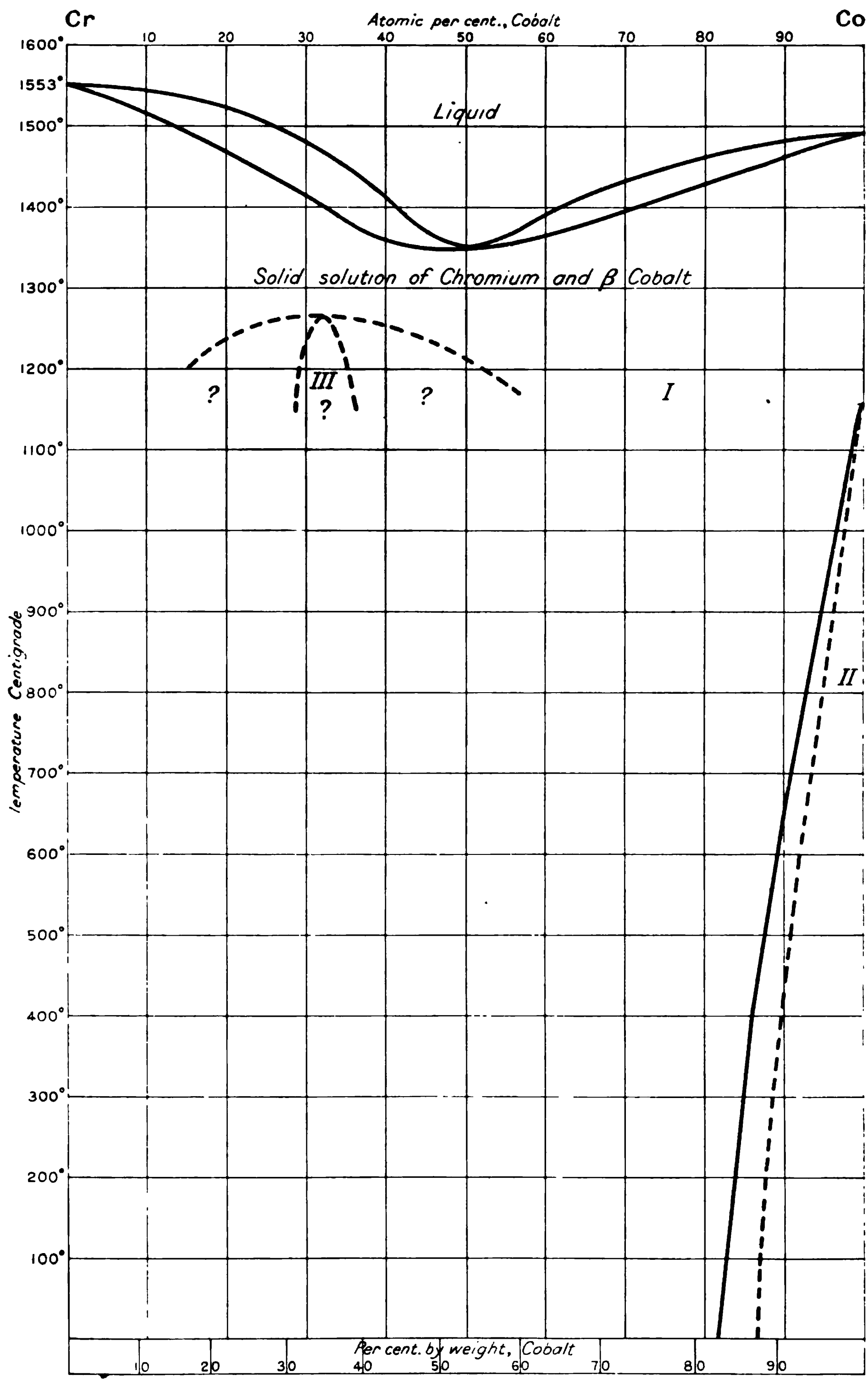

Figure 6.—Equilibrium Diagram of Chromium-Cobalt Alloys.

Cobalt and Chromium

The equilibrium diagram of the cobalt chromium alloys is shown in Figure 6.[1] Both metals are soluble in one another in the liquid and also in the solid state. The liquidus curve shows a minimum at approximately 50 per cent. cobalt and 1340°C. In alloys containing between 45 per cent. and 85 per cent. chromium there is a reaction in the solid state at approximately 1225°C., the homogeneous solid solution above that temperature breaking down into two solid solutions. Alloys with 0 to 45 per cent. chromium show a polygonal structure containing cobalt rich cores, the chromium content increasing from the centre to the outside. In alloys with more than 55 per cent. chromium, the chromium content of the grains decreases from the centre to the outside.

The temperature at which the unmagnetic cobalt chromium alloys become magnetic decreases rapidly with increasing chromium content. The addition of 10 per cent. chromium lowers the transformation point to 685°; 15 per cent. to 300°; while the addition of 25 per cent. lowers the transformation to below room temperature.

Special alloys containing cobalt and chromium are known as "stellite." The word is derived from the Latin, stella, a star, and was chosen because of the brilliant polish these alloys take and retain under atmospheric conditions. An alloy containing 75 per cent. cobalt and 25 per cent. chromium is fairly tough and hard, and may be forged. This alloy is only slightly attacked by nitric acid, and is recommended for cutlery. To increase the hardness of the stellite alloys, varying amounts of either tungsten or molybdenum, or both, are added, the chromium in the alloy remaining about 30 per cent. The addition of 5 per cent. tungsten produces a distinctly harder alloy, which forges readily. With 10 per cent. the metal may be forged, and takes a fine cutting edge. This alloy is suitable for cold-chisels and wood-working tools. With 15 per cent. the metal may still be forged, but only with great care, as it is considerably harder than the 10 per cent. tungsten alloy. With 20 per cent. the alloy is still harder. It may be forged, but only to a limited extent. This alloy is adopted for cutting steel and other metals at a moderate speed. With 25 per cent. a hard alloy is obtained which cannot be forged, but is cast into bars which are ground to a suitable form for lathe tools. These tools are used to cut steel and cast iron, and retain their hardness at high speeds. When the tungsten content reaches 40 per cent. the alloy still retains its cutting qualities, and is preferred to the 25 per cent. alloy for cast iron. Further additions of tungsten produce brittleness. It is claimed these alloys possess an advantage of 20 to 100 per cent. over high-speed tool steels.

Molybdenum produces somewhat the same effect as tungsten, only a smaller proportion is required. An alloy containing 10 per cent. of molybdenum makes an excellent lathe tool. Carbon, silicon, and boron when present impart brittleness.

[1] Guertler, Metallographie, Vol. I, pp. 359-361. Lewkonja, Cobalt-Chromium Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, pp. 323-327.

A few typical analyses[1] of stellite alloys are given below, but it must be remembered that for the successful use of stellite different alloys must be used for different classes of work.

Co	Cr	W	Mo	
75	25	..	..	Original stellite alloy.
70	25	5	..	Forges readily, suitable for wood-cutting tools and cutlery.
60	15	25	..	Suitable for lathe tools for cutting steel and cast iron.
55	35	10	..	
50	30	20	..	
55	15	25	5	High speed cutting tools.
45	15	..	40	Very hard alloy.

Stellite alloys also contain a small percentage of carbon.

The stellite alloys are covered by a number of patents, the numbers of which are given below.

Haynes, U. S. Patent No. 873,745, Dec. 17, 1907. Alloys containing 10-60 per cent. chromium, and 90-40 per cent. cobalt.

U. S. Patent No. 873,746, Dec. 17, 1907. Alloy of 30-60 per cent. chromium and 70-40 per cent. nickel.

U. S. Patent 1,057,423, and 1,057,828, April 1, 1913. The addition of tungsten and molybdenum to the cobalt-chromium alloy is specified in these patents to produce greater hardness and toughness.

U. S. Patent No. 1,150,113, Aug. 17, 1915. Alloy for tools containing approximately cobalt 25 per cent., chromium 20, and iron 55. Molybdenum may be added to vary the colour. More chromium increases the hardness and iron renders the alloy more fusible, malleable and softer.

British Patent 2,487, August 17, 1915 (similar to U. S. Patent 1,057,423).

British Patent No. 100,434, Jan. 5, 1916. Cobalt-chromium alloys containing sufficient iron or nickel to soften the metal. This alloy is known as "festal metal."

Tamman, German Patent 270,750, August 14, 1909. A cobalt-chromium alloy for machine parts, containing 20.23 per cent. chromium and 80-77 per cent. cobalt.

Alloys of nickel and copper or cobalt and one of the following metals, namely, chromium, tungsten, molybdenum, vanadium, aluminium and uranium are used extensively for thermo-electric couples and resistance elements. These are covered by a number of patents granted to Albert L. Marsh, the dates and numbers of most of them being given below.

U.S. Patents Nos. 779,090, Jan. 3, 1905; 781,288, Jan. 31, 1905; 781,289, Jan. 31, 1905; 781,290, Jan. 31, 1905; 786,577, April 4, 1905; 811,859, Feb. 6, 1906: 853,891, May 14, 1907; 859,608, July 9, 1907; 874,780, Dec. 24, 1907; 971,767, Oct. 4, 1910.

Shortly after Marsh's patents were published the General Electric Company manufactured a similar alloy, "calorite," of the composition given below. The validity of Marsh's patents has been affirmed, and at present the Hoskins Electric Company are producing nickel-chromium alloys under the Marsh patents.

[1] Haynes, Alloys of Nickel and Cobalt with Chromium: Jour. Ind. and Eng. Chem., Vol. II, 1910, pp. 397-401.

In the patent suit defence the General Electric Company cited Placet's patent (Br. pat. 202, 1896) as antedating the Marsh patents. It appears that Placet found that the addition of chromium to other metals increased the hardness, toughness, and electrical resistance, but was not aware of the durability of the alloy, which latter property is one of the main advantages of nickel-chromium alloys.

The Driver Harris Company manufactured a nickel-chromium alloy containing 25 per cent. iron shortly after the General Electric Company made calorite. At the present time it is understood that the Hoskins Manufacturing Company control the Marsh patents, and all nickel-chromium alloys are made under a license from them.

The analyses of the various nickel-chromium alloys are given below.

	Ni	Cr	Fe	Mn	Specific Resistance.
Calorite	65	12	15	8	110
Nichrome	60	11	25	4	105
Nichrome 2	75	11	12	2	110
Excello	85	14	0.5	0.5	92
Tophet	61	10	26	3	107
Calido	64	8	25	3	106
Chromel A.	80	20	..	2	102
Chromel B.	85	15	..	2	88
Chromel C.	60	12	25	4	106

With regard to the use of nickel-chromium alloys,[1] it may be stated that the addition of iron makes the working of the alloys much easier, but lowers the resistance of the alloy to oxidation. The great resistance to oxidation of the nickel chromium alloys is not due to the nickel or the chromium but to the scale formed. The addition of iron also lowers the resistance of the scale, especially with temperatures above 1350°F. The lower the iron content, the higher temperature at which it is possible to operate.

Nichrome "2" is manufactured to compete with chromel "A," but owing to the iron content cannot be operated successfully above 1700°F., whereas chromel A may be used successfully at 2000°F.

Chromel "C" was placed on the market to supply a cheap alloy that could be successfully used for small heating apparatus, e.g., electric stoves, irons, etc., where the wire is exposed to the air and not allowed to heat above 1350°F.

A report has been made that a cobalt-chromium alloy, cochrome, may be swaged into wires which are in some respects superior to nichrome wires in electric heating elements. They are less readily oxidized at high temperatures and have a higher melting point.

Additional References

Hibbard, Manufacture and Uses of Alloy Steels, Bulletin 100, 1915, p. 60. Bureau of Mines, Washington.

Haynes, Stellite, Met. Chem. Eng., Vol. 18, 1918, pp. 541-542.

Haynes, The Development of Stellite, Iron Age, Vol. 102, 1918, pp. 886-888.

Guillet and Godfroid, Some Observations on Stellite, Revue de Métallurgie (Mémoires), Vol. 15, 1918, pp. 339-346.

Stellite, Canadian Machinery, Vol. XIX, 1918, pp. 231-235.

[1] Private communication.

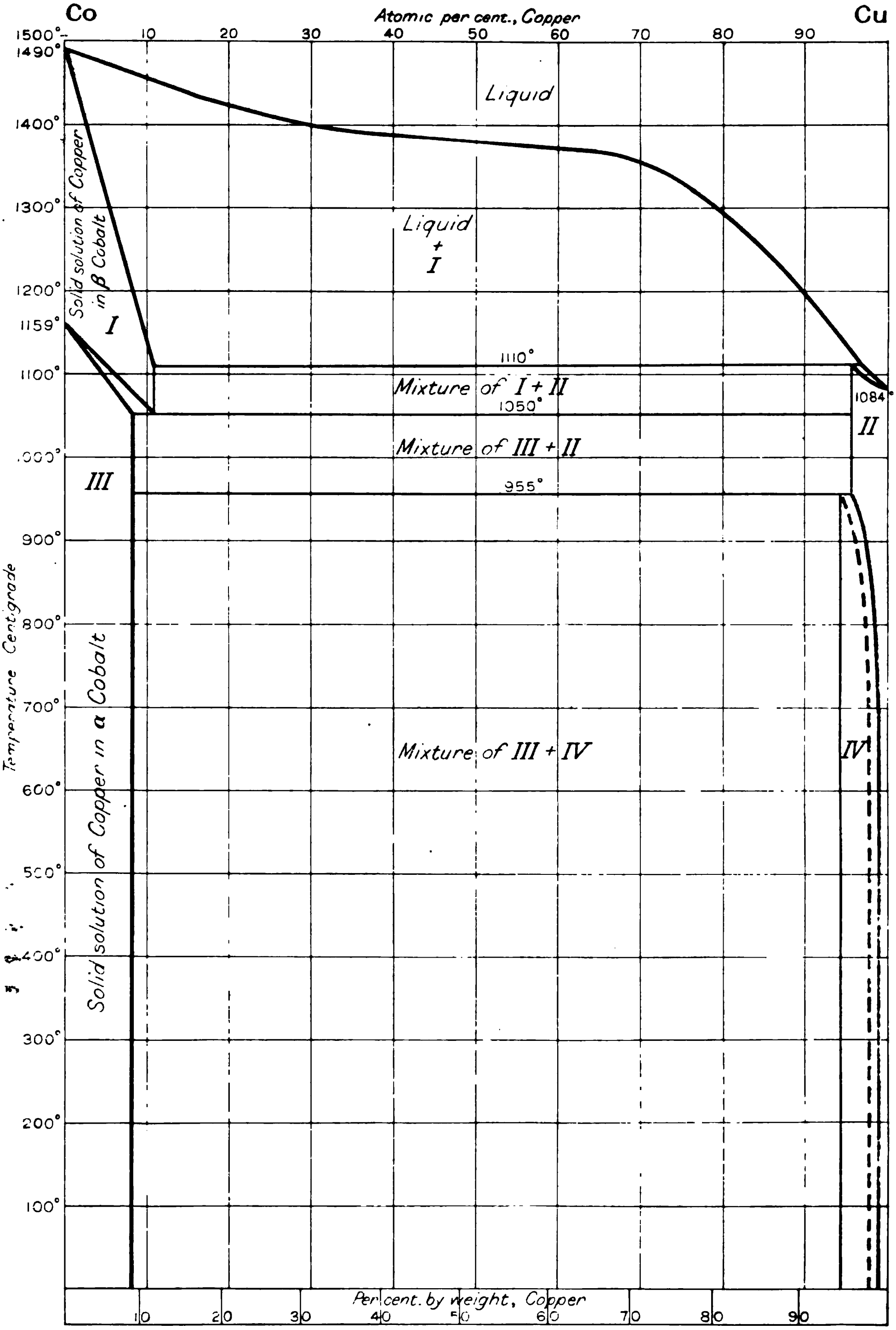

Figure 7.—Equilibrium Diagram of Cobalt-Copper Alloys.

Cobalt and Copper

The equilibrium diagram[1] of the cobalt-copper system is shown in Figure 7. The metals are completely soluble in the liquid state, but form two solid solutions in the solid. The cobalt-rich solid solution contains from 0 to 10 per cent. of copper, and the copper-rich solid solution 0 to 4 per cent. of cobalt. At 1110°C. with mixtures containing between 10 and 96 per cent. copper, there is a reaction, with the formation of the solid solution II. Below 955°C. a new solution IV containing, at room temperature, from 95 to 98 per cent. of copper, separates. This solid solution is remarkably magnetizable. The temperature of the transformation of the β cobalt solution to the α form is lowered with increase of copper from 1159° to 1050°C., where it remains constant for mixtures between 10 and 96 per cent. copper. The hardness of copper-cobalt alloys increases directly with the cobalt. Addition of either metal to the other rapidly decreases the electrical conductivity.

Additional References

Konstantinow, Alloys of Cobalt and Copper: Revue de Métallurgie (Mémoires), Vol. IV, 1907, p. 983.

Ducelliez, Studies of the Alloys of Cobalt and Copper: Procès verbaux de la société des sciences physiques et naturelles de Bordeaux, 1908-1909, pp. 120-126.

Chemical Study of Alloys of Cobalt and Copper: Bulletin de Société Chimique de France. Vol. VII, 1910, pp. 158-160, 196-198.

Waehlert, Cobalt-Nickel-Copper Alloys: Osterr. Zeitschr. Berg. u. Hüttenwesen, Vol. LXII, 1914, pp. 341, 357, 374, 392, 406.

Guertler, Metallographie, Vol. I, 1912, pp. 83-84.

Rosenhain, Electric Conductivity of Alloys of Cobalt and Copper, Introduction to Physical Metallurgy, 1914, p. 112.

Kaiser, Metallurgie, Vol. 8, 1911, p. 300. Analysis of white bronze (Cu 40-30, Co 50-60, Al 10), p. 305, Analysis of metalline (Cu 30, Co 35, Al 25, Fe 10).

Cobalt and Gold

The equilibrium diagram of the cobalt-gold series is shown in Figure 8.[2] The eutectic point which is given at approximately 90 per cent. gold and 997°C., as well as other parts of the liquidus and solidus, have not been accurately determined. In the experiments with the cobalt-rich alloys there was a marked tendency toward undercooling. Cobalt retains approximately 10 per cent. gold in solid solution, and gold retains several per cent. of cobalt, the solubility varying with the temperature. The transformation temperature of β into α cobalt has not been determined accurately.

Additional Reference

Guertler, Metallographie, Vol. I, 1912, pp. 345-348.

[1] Sahmen, Alloys of Copper and Cobalt: Zeitschr. anorg. Chemie, Vol. LVII, 1908, pp. 1-9.

[2] Wahl, Cobalt-Gold Alloys: Zeitschr. anorg. Chemie, Vol. LXVI, 1910, pp. 60-72.

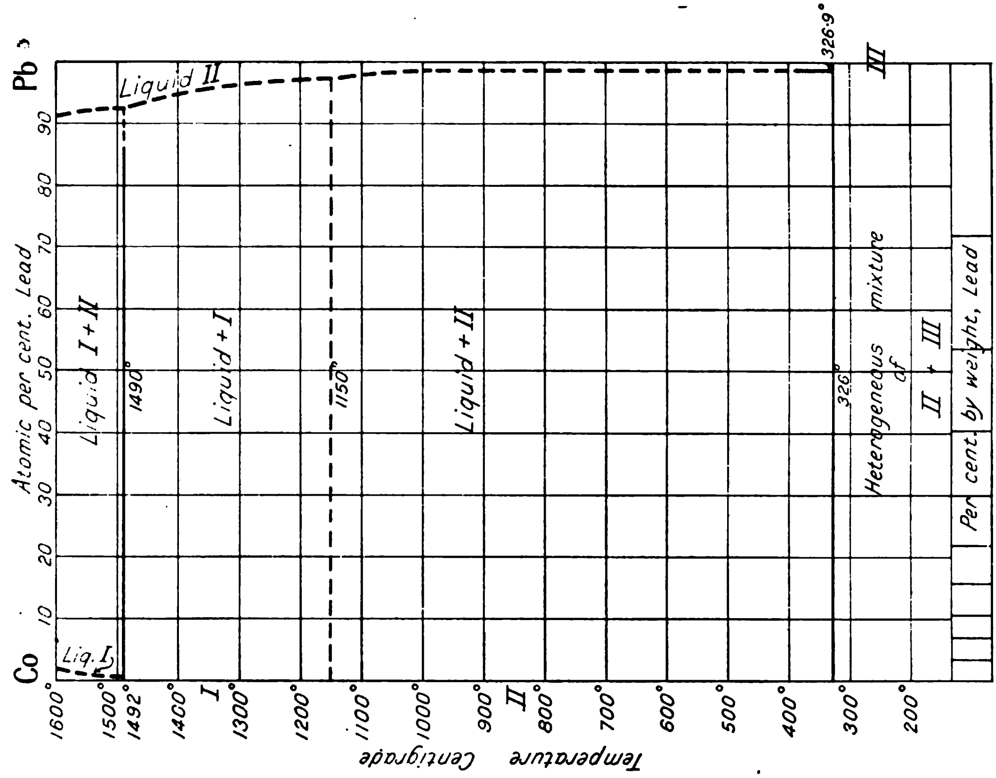

Figure 9.—Equilibrium Diagram of Cobalt-Lead Alloys.

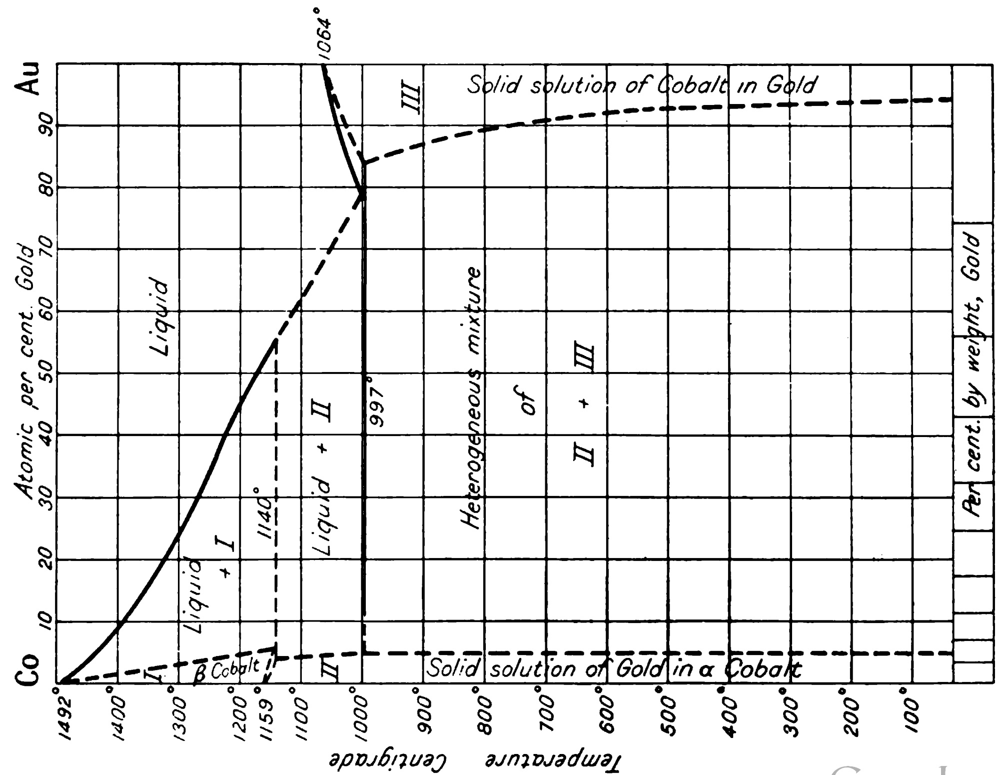

Figure 8.—Equilibrium Diagram of the Cobalt-Gold Alloys.

Cobalt and Iron

The equilibrium diagram of the cobalt-iron alloys is shown in Figure 12.[1] The two metals form a complete series of solid solutions.

A more complete diagram has been published by Ruer and Kaneko. In this diagram the two metals form a series of solid solutions with a minimum between 30 and 40 per cent. of iron and at about 1450°C. By the addition of cobalt the melting point of iron is lowered. The branch of the curve on the iron side of the diagram shows a reaction between the solid solution containing 15.5 per cent. of cobalt with the liquid containing 22 per cent. of cobalt to form a solid solution containing 19 per cent. of cobalt. The two branches of the iron curve then rise, intersecting at 1520°C., the melting point of iron.

In the same diagram the curve of magnetic transformation of iron alloys is also shown. The curve shows a maximum at 55 per cent. of iron and 985°C., which composition approaches very closely that of the compound Fe_4Co. With alloys containing less than 85 per cent. iron, the unmagnetic γ iron changes directly to the α magnetic form. With alloys containing between 100 and 85 per cent. of iron, the γ iron passes through the β form. A curve showing the transformation of β to α cobalt is also shown.

An alloy of iron, nickel, and cobalt with additions of chromium, molybdenum, tungsten, and other metals has been patented by Borchers. (For a more complete description of this alloy, see under Cobalt and Nickel.)

Yensen has investigated the magnetic properties of the iron-cobalt alloy, Fe_2Co, which contains approximately 30 per cent. of cobalt. He states that in this iron-cobalt combination, an alloy is found that is suitable for use in places where the magnetic density is very high, such as armature teeth of dynamo machinery. While its electrical resistance is low, there is reason to believe that this may be raised by the addition of other alloying elements.

Kalmus undertook a series of experiments to test whether the addition of cobalt to sheet iron had any marked effect on corrosion. The results obtained, though not conclusive, showed that cobalt in amounts up to 3 per cent. had a beneficial effect.

Additional References

Ruer and Kaneko, The Iron-Cobalt System: Ferrum, Vol. XI, 1913, p. 33.

Ruer and Klesper, The Gamma-Delta Transformation of Pure Iron, and the Effect of Carbon, Silicon, Cobalt, and Copper: Ferrum, Vol. XI, 1913, pp. 259-261.

Guertler and Tamman, Alloys of Nickel and Cobalt with Iron: Zeitschr. anorgan. Chemie, Vol. XLV, 1905, pp. 205-224.

Yensen, The Iron-Cobalt Alloy Fe_2Co, and its Magnetic Properties: General Electric Review, Vol. XVIII, 1915, pp. 881-887.

Mathews, Metallic Conduction and the Constitution of Alloys: Electrical World and Engineer, Vol. XL, 1902, pp. 531-533.

Weiss, The Magnetic Properties of the Alloys of the Ferro-Magnetic Metals, Iron-Nickel, Nickel-Cobalt, and Cobalt-Iron: mention is made of Fe_2Co. Transactions Faraday Society, Vol. VIII, 1912, pp. 149-156. Revue de Metallurgie (Memoires) Tome IX, 1912, pp. 1135-1143.

Kalmus, Magnetic Properties of Cobalt and of Fe_2Co, Bulletin 413, Department of Mines, Canada, 1916.

Kalmus and Blake, Cobalt Alloys with Non-Corrosive Properties, Bulletin 411, 1916.

Fuller, Thermo-electric Force of Certain Iron Alloys: Amer. Electrochem. Soc., Vol. XXVII, 1915, pp. 241-251; Met. Chem. Eng., Vol. XIII, 1915, pp. 318, 319.

[1] Guertler, Metallographie, Vol. I, 1912, pp. 78-81.

Becket, F. M., Manufacture of an alloy of approximately the composition given by Fe_2Co, containing 2 to 6 per cent. silicon. United States Patent, No. 1,247,206, Nov. 20th, 1917.

Honda and Takagi, The Irreversibility of Nickel and Cobalt Steels, Chem. Abst., Vol. XI, 1917, p. 2449.

Effect of Cobalt on Steel

Owing to the importance of nickel steels and because of the close association and similar chemical properties of nickel and cobalt, numerous experiments have been made to ascertain whether cobalt produced any marked effect similar to that of nickel on the properties of steel.

From the tests conducted so far it has been shown that cobalt has a beneficial effect on certain steels and for certain uses, but that its behaviour is very different from that of nickel.

Hadfield,[1] who was about the first to investigate the effect of the addition of cobalt to steel, concluded that cobalt raised the elastic limit and tensile strength. The amount of cobalt added varied from 0.0 to 6.9 per cent., and the steel contained 0.64 to 1.2 per cent. silicon and 0.10 to .14 per cent. sulphur.

Guillet[2] conducted a series of experiments by adding cobalt to a 0.8 per cent. carbon steel, in amounts up to 30 per cent. He also prepared a few samples containing 50 and 60 per cent. cobalt. The tests showed that the tensile strength increased with the proportion of cobalt, but that no sudden change in the mechanical properties occurred.

Arnold and Read[3] investigated the effect of cobalt on steel and concluded that the additions of cobalt increased the tensile strength, but cobalt did not show the same tendency to precipitate carbon in the form of graphite as nickel does.

Although cobalt steels have shown greater strength than the ordinary carbon steels, it is possible that this increased strength may be obtained more cheaply by the addition of other metals. However, the addition of cobalt to high-speed steels appears to produce an improvement in the cutting properties, and considerable quantities are being used at present for this purpose. In some cases it is claimed the life of high-speed steels containing cobalt, is increased several times.

The effect of cobalt on high-speed steels is quite different from that of nickel. The addition of between 5 and 10 per cent. of cobalt to steel produces a good high-speed steel, while the addition of nickel has an altogether different effect, since it produces a metal with a soft edge.

The valuable properties imparted by addition of cobalt to steel appear to be due to an increase in the hardness of the steel when at a red heat, thereby enabling the steel to cut at a higher speed.

A number of comparative cutting tests have been made by Schlesinger,[4] and the results show a distinct advantage in favour of cobalt high speed steels. One of the high-speed cobalt steels tested contained C 0.76, Si 0.28, Co 5.0, Cr. 4.4, W. 16.4, and V. 0.62 per cent. This analysis corresponds very closely with an alloy steel called Rex AAA.

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[1] Hadfield. Iron and Steel Alloys: Iron and Steel Magazine. Vol. VII, 1904, p. 10.
[2] Guillet, Cobalt Steels: Revue de Metallurgie (Memoires), Vol. II, 1905, pp. 348-349.
[3] Arnold and Read. The Chemical and Mechanical Relation of Iron, Cobalt and Carbon: Engineering, Vol. XCVIII, 1915, pp. 346-348, 362-364.
[4] Schlesinger, The Improvement of German Steel Works by the production of High-Speed Steel Alloys: Stahl und Eisen, Vol. XXXIII, 1913, pp. 929-939.

Becker[1] has obtained a patent specifying the use of cobalt in high-speed tool steels. The granting of this patent was opposed by a large number of European manufacturers, but the decision[2] was given in favour of Becker.

A later report[3] states that the patent granted to Becker has been revoked by a decision of a British Court.

Darwin and Milner[4] claim to have discovered a cobalt-chromium steel equal to the Becker iridium-cobalt-tungsten steel. One advantage of the new product is that it may be hardened at a temperature 300°C. below that required for the tungsten steel.

Additional References

Hibbard, Manufacture and Uses of Alloy Steels: Bulletin 100, 1915, p. 60, Bureau of Mines, Washington.
Chromium Nickel, and Cobalt in Pig Iron: Iron Age, Vol. LXXX, 1907, p. 488.
Abstract of Schlesinger's tests on Cobalt Steel: Iron Age, Vol. XCII, 1913, p. 33.
Lantsberry, High-Speed Tool Steel: Iron Age, Vol. XCVI, 1915, pp. 238-241.
German High-Speed Steel: Iron Age, Vol. XCVIII, 1916, p. 1111.
Browne, Metals and Alloys in the Steel Industry: Vol. XCVII, 1916, p. 76.

Cobalt and Lead

The equilibrium diagram of the cobalt-lead series is shown in Figure 9.[5] The solubility of the two metals in the liquid state is very small.

The transformation line of cobalt was not determined, but on account of the small solubility of lead it must lie practically at 1159°C.

Additional References

Lewkonja, Cobalt-Lead Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, pp. 312-315.
Ducelliez, Study of the Alloys of Cobalt and Lead: Bulletin Société Chimique, Vol. III, 1908, pp. 621-622.
Chemical Study of the Alloys of Cobalt and Lead: Procès verbaux de la Société des sciences physiques et naturelles de Bordeaux, 1908, pp. 31-34.
A Study of the Electromotive Force of Cobalt-Lead Alloys: Bulletin Société Chimique, Vol. VII, 1910, pp. 201-202.
Bornemann, Cobalt and Lead: Metallurgie, Vol. VIII, 1911, pp. 361-362.

Cobalt and Magnesium

Very few experiments have been made to prepare cobalt-magnesium alloys. Parkinson[6] attempted to prepare a mixture or alloy of these metals by adding magnesium to molten cobalt. However, he obtained only small amounts of magnesium in the solid alloy. The experiments were not carried far enough to warrant any conclusions.

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[1] German Patent, No. 281,386, Aug. 10th, 1912. Manufacture of High-Speed Cobalt Steels. An approximate analysis of a High-Speed Cobalt Steel is given as C 0.7, Cr 5, W 18, V 1, Mo 0.75 and Co 10 per cent.
United States Patent, No. 1,081,263, December 9th, 1913. Also a British patent.
[2] Iron Age, Vol. XCIII, 1914, p. 453.
[3] Iron Age, Vol. 101, 1918, p. 321.
[4] Darwin and Milner, Cobaltchrome Tool Steel, Engineering, Vol. CIV, 1917, p. 22.
[5] Guertler, Metallographie, Vol. I, 1912, p. 582.
[6] Guertler, Metallographie, Vol. I, 1912, p. 415.

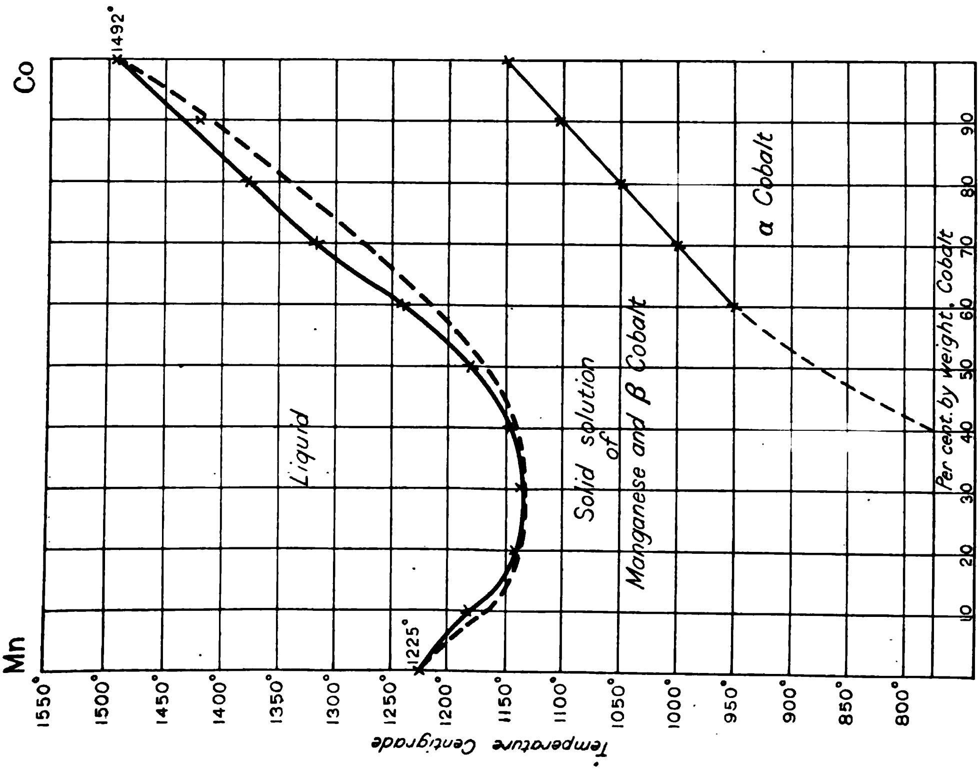

Figure 10.—Equilibrium Diagram of Manganese-Cobalt Alloys.

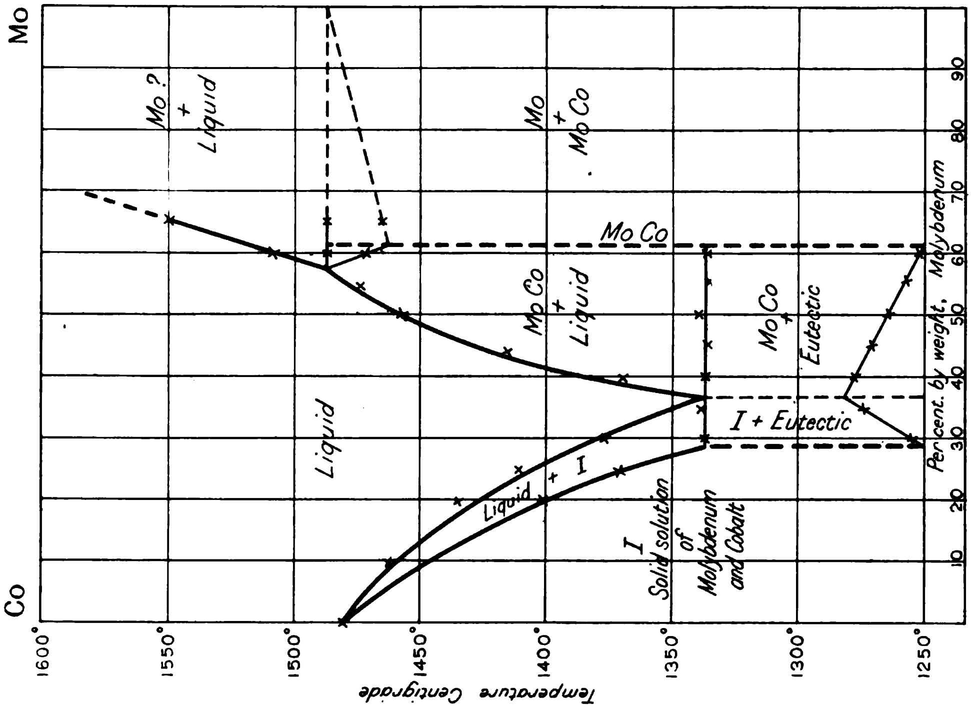

Figure 11.—Equilibrium Diagram of Cobalt-Molybdenum Alloys.

Cobalt and Manganese

The equilibrium diagram of the cobalt-manganese series is shown in Figure 10.[1] A minimum exists at approximately 30 per cent. cobalt and 1140°C. The alloys in solidifying exhibit a strong tendency toward undercooling. Alloys with more than 40 per cent. cobalt are not homogeneous, but become more nearly so by annealing at 1000°C. for 5 hours. Those alloys containing more than 40 per cent. cobalt were magnetic, the magnetism rising rapidly with increased cobalt content. In the original article Hiege shows the melting points of cobalt and manganese at 1525° and 1250° C. respectively. As this temperature for cobalt is about 25°C. higher than that used in the other diagrams, in reproducing the cobalt-manganese diagram all Hiege's temperatures have been reduced by 25°.

Huntington[2] states the addition of manganese to cobalt renders cobalt malleable.

Additional References

Arrivant, Alloys of Manganese with Nickel, Cobalt, and Vanadium: Procès verbaux de la Société des sciences physiques et naturelles de Bordeaux (Memoires), 1905-1906, pp. 105-114, 152-154.

Guertler, Metallographie, Vol. I, 1912, p. 90.

Guertler, The Magnetizability of the Alloys of the Ferro-Magnetic Metals, Zeitschr. physikal. Chemie, Vol. 65, 1908, pp. 73-83.

Cobalt and Molybdenum

The equilibrium diagram of the cobalt molybdenum alloys is shown in Figure 11.[3] Owing to the difficulty of obtaining homogeneous liquid melts at 1800°C., alloys with more than 65 per cent. molybdenum have not been prepared. A eutectic of a cobalt solid solution and the compound MoCo occurs at 1335°C., and 37 per cent. molybdenum. At the eutectic temperature cobalt retains 28 per cent. molybdenum in solid solution. At 1488°C., the compound MoCo (62 per cent. Mo) is formed by a reaction.

Alloys containing up to 60 per cent. molybdenum are magnetic, but those containing between 50 and 60 per cent. are very feebly so.

Additional Reference

Guertler, Metallographie, Vol. I, 1912, pp. 378-379.

Cobalt-Nickel Alloys

The equilibrium diagram of the cobalt-nickel alloys is shown in Figure 13.[4] The liquidus and solidus lie practically in a straight line between the melting points of the pure metals. The transformation temperatures of pure nickel and cobalt occur at about 320°C., and 1159°C. respectively.

[1] Hiege, Alloys of Manganese with Cobalt: Zeitschr. anorg. Chemie, Vol. LXXXIII, 1913, pp. 253-256.

[2] Huntington, Metallurgy of Nickel and Cobalt, Jour. Soc. of Chem. Ind., Vol. I, 1882, p. 258.

[3] Raydt and Tamman, Molybdenum-Cobalt Alloys: Zeitschr. anorg. Chemie, Vol. LXXXIII, 1913, pp. 246-252.

[4] Guertler, Metallographie, Vol. I, 1912, p. 81.

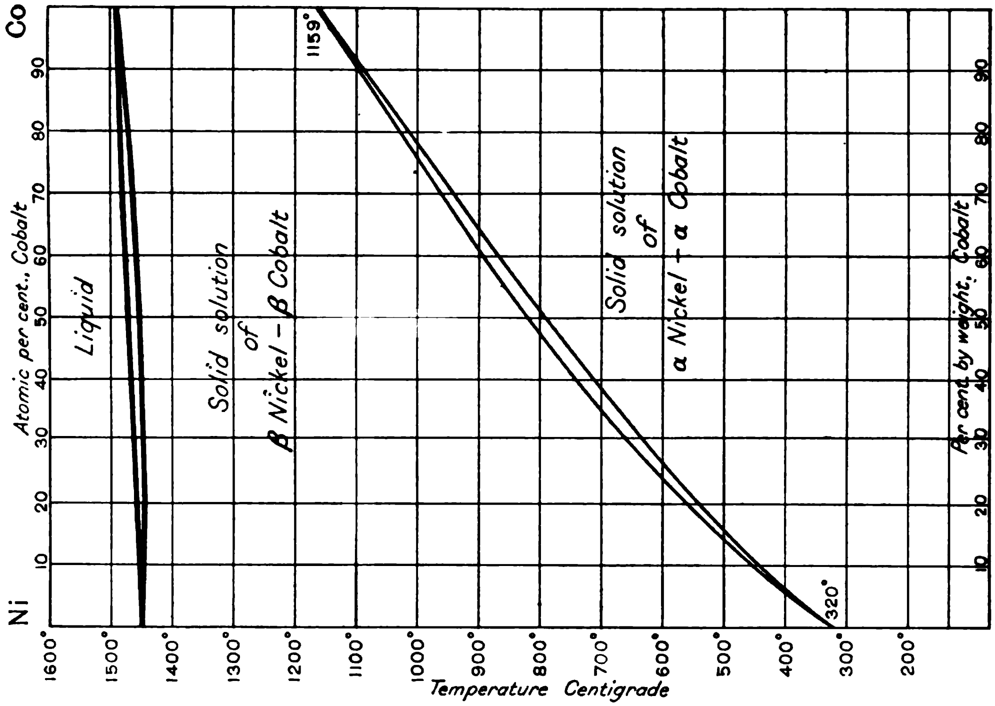

Figure 13.—Equilibrium Diagram of Nickel-Cobalt Alloys.

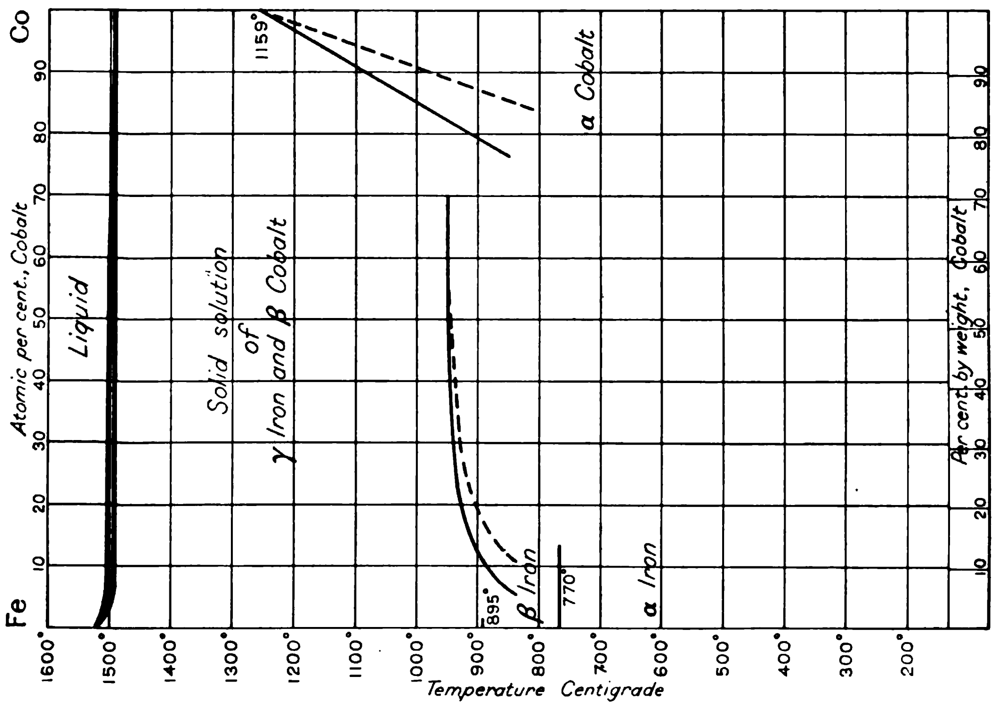

Figure 12.—Equilibrium Diagram of Iron-Cobalt Alloys.

The hardness of the cobalt-nickel alloys remains practically constant until 60 per cent. cobalt is reached, when the hardness increases rapidly with increased percentage of cobalt.

Certain alloys of cobalt and nickel are only slightly attacked by acids, and a number of patents have been granted for acid-resistant cobalt-nickel alloys with the addition of a third or fourth metal for certain other properties.

The first patent[1] was granted to Borchers for an alloy of high chemical resistance, combined with good mechanical properties. It contained approximately 67.5 per cent. nickel, 30 chromium, and 2.5 silver. The addition of silver is said to improve the mechanical properties. Later[2] copper was substituted for the silver.

The next patent[3] was for an acid resistant and mechanically workable nickel-cobalt-silver alloy, the proportions being 39.5: 60: 0.5 respectively. It was found later[4] that the nickel in the first patent may be replaced by an equal amount of cobalt, and the silver wholly or partly by copper. Subsequently, the silver and copper mentioned in the previous patent were replaced by molybdenum.

A later patent[5] granted for chemically resistant and mechanically workable alloys specified the substitution of gold, metals of the platinum group, or tungsten, for the molybdenum in the first mentioned patent.

Another patent[6] was granted whereby up to 90 per cent. of the nickel in the previous patents may be replaced by iron. This was followed by a patent[7] covering the alloys of iron, nickel, and cobalt and their alloys with one another, with additions of chromium between 25 and 35 per cent. and below 5 per cent. of one or more of the following metals: molybdenum, tungsten, platinum, iridium, osmium, palladium, rhodium, ruthenium, tin, silver, and copper.

Cobalt-Nickel-Copper Alloys

An extensive investigation of the cobalt-nickel-copper alloys was undertaken by Waehlert.[8] From the tests he concluded that the addition of cobalt to copper-nickel alloys shows an improvement in the tensile strength, hardness, and working properties. The ternary alloys were quite resistant to sulphuric acid (20 per cent. or more) but were attacked more vigorously by nitric acid. The greatest hardness of the series of alloys occurs when the cobalt and nickel are in approximately equal proportions. The colour of the alloys changes from copper-red to white with 50 per cent. of combined cobalt and nickel.

Additional References

Guertler and Tamman, Alloys of Cobalt and Nickel: Zeitschr. anorg. Chemie, Vol. XLII, 1904, pp. 353-363.

Weiss, The Magnetic Properties of the Alloys of the Ferro-Magnetic Metals, Iron-Nickel, Nickel-Cobalt, Cobalt-Iron: Transactions Faraday Society, Vol. VIII, 1912, pp. 149-156.

[1] German Patent, No. 255,919, June 21st, 1912, W. Borchers and R. Borchers.
[2] German Patent, No. 257,380, August 20th, 1912, Gebr. Borchers.
[3] German Patent, No. 256,123, June 21st, 1912, Gebr. Borchers.
[4] German Patent, No. 256,361, August 20th, 1912, W. Borchers and R. Borchers.
[5] German Patent, No. 265,076 and No. 265,328, Feb. 11th, 1913, W. Borchers and R. Borchers.
[6] German Patent, No. 268,516, June 12th, 1913, W. Borchers and R. Borchers.
[7] British Patent, No. 18,212, August 11th, 1913, W. Borchers and R. Borchers.
[8] Waehlert, Cobalt-Nickel-Copper Alloys: Osterr. Zeitschr. Berg. u. Hüttenwesen, Vol. LXII, 1914, pp. 341, 361, 375, and 392-406.

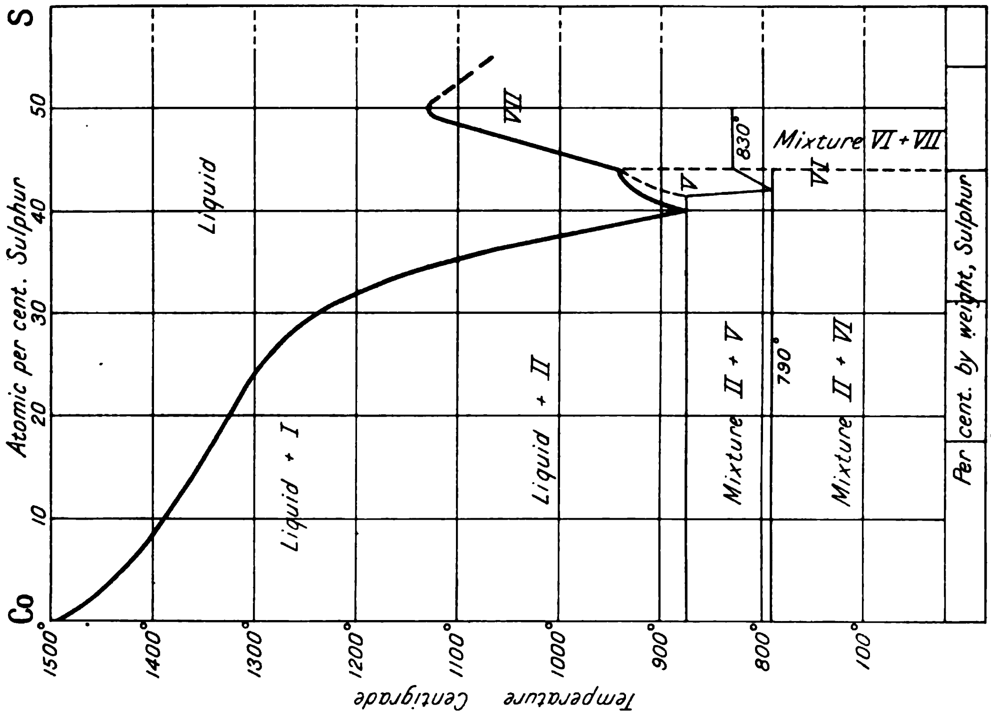

Figure 16.—Equilibrium Diagram of Cobalt-Sulphur Alloys.

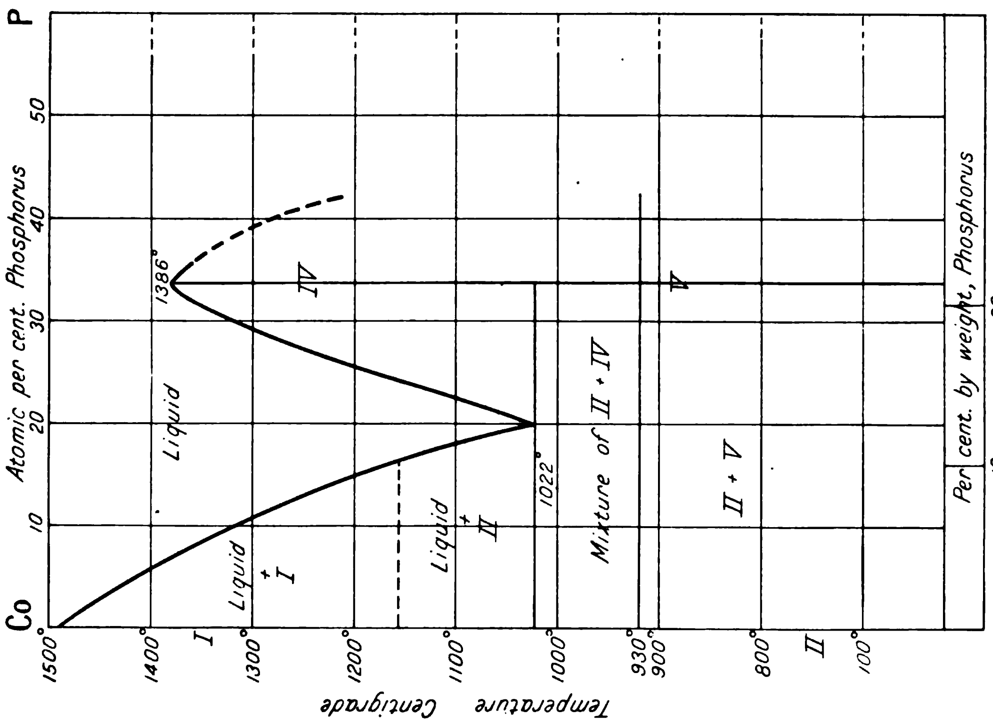

Figure 14.—Equilibrium Diagram of Cobalt-Phosphorus Alloys.

Ruer and Kaneko, The Nickel-Cobalt System: Metallurgie, Vol. IX, 1912, pp. 419-442.
The Specific Resistance and Hardness of Nickel-Cobalt Alloys: Ferrum, Vol. X, 1913, pp. 257-260.
Weiss and Bloch, Magnetism of Nickel and Cobalt and the Alloys of Nickel and Cobalt: Compt. Rend., Vol. CLIII, 1911, pp. 941-943.

Cobalt and Phosphorus

The equilibrium diagram of the cobalt-phosphorus alloys up to 20.7 per cent. phosphorus, is shown in Figure 14.[1] The addition of phosphorus lowers the melting point of cobalt to a eutectic point at 1022°C. and 11.5 per cent. phosphorus. From the eutectic point the curve rises rapidly to a maximum at 1386°C., the melting point of the compound Co_2P. Difficulty was experienced in preparing mixtures containing higher concentrations of phosphorus.

At 920°C. the separated crystals of Co_2P undergo a transformation, forming other crystals of similar composition.

Additional Reference

Guertler, Metallographie, Vol. I, 1912, pp. 888-890.

Cobalt and Selenium

The equilibrium diagram of the cobalt-selenium alloys has not yet been investigated. Partial investigations seem to indicate the formation of the compounds CoSe and Co_3Se_4.[2]

Cobalt and Silicon

The equilibrium diagram of the cobalt-silicon alloys is shown in Figure 15.[3] The curve shows two solid solutions, four eutectic points, and five compounds; one of the compounds, mentioned again below, being formed by a reaction in the solid state, and another by a reaction between separated crystals and liquid. Cobalt retains 7.5 per cent. silicon in solid solution at 1204°C., while silicon retains approximately 9 per cent. cobalt in solid solution at about 1250°C.

The eutectic point B lies at 1204°C. and 15 per cent. silicon. Further additions of silicon cause the melting point curve to rise to C at 19.5 per cent. silicon and 1327°C., corresponding to the compound Co_2Si. With further additions of silicon the melting point curve is lowered to the eutectic point D at 1249°C. and 25.5 per cent. silicon. Below 1249°C. a change occurs in the eutectic, as shown by the line c d e, with the formation of a new compound Co_3Si_2. Further additions of silicon cause another rise in the melting point curve to E, at approximately 1395°C., and 32.5 per cent. silicon, corresponding to the compound CoSi. A lowering of the curve occurs again with increased silicon. At F a reaction occurs between the compound CoSi and liquid F to form a new compound $CoSi_2$, the composition of which is very near that of F. From F the curve drops to the eutectic point G at 1213°C., and approximately 54 per cent. silicon. Again there is a rise in the melting-point curve to H, at 1310°C. and 59 per cent. silicon,

[1] Zemczuzny and Schepelew, Phosphorus Compounds of Cobalt: Zeitschr. anorg. Chemie, Vol. LXIV, 1908, pp. 245-257.
[2] Guertler, Metallographie, Vol. I, 1912, p. 951.
[3] Lewkonja, Cobalt-Silicon Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, pp. 317-338. Revue de Métallurgie, Vol. 8, 1909, p. 954.

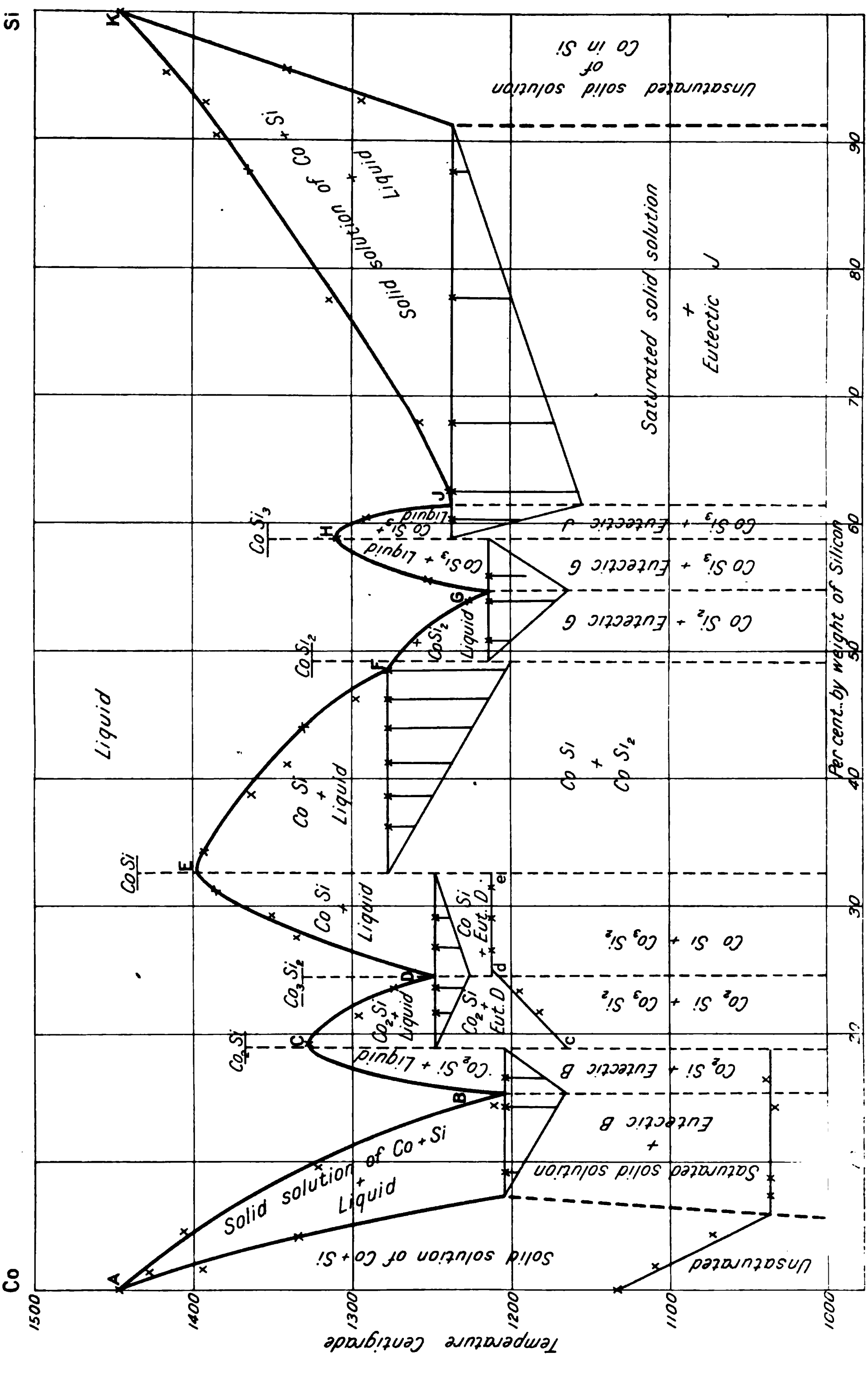

Figure 15.—Equilibrium Diagram of Cobalt-Silicon Alloys.

corresponding to the compound $CoSi_3$. The curve then falls to the eutectic J at 1236°C., and 62 per cent. silicon. From J the melting-point curve rises to K at 1425°C., the melting point of silicon.

Additional References

Lebeau, Silicides of Cobalt: Annales de Chimie et de Physique, Paris, Vol. XXVII, Sér. 7, 1902, pp. 271-277.

Combinations of Silicon with Cobalt and a new Silicide of this Metal: Compt. Rend., Vol. CXXXV, 1902, pp. 475-477.

Vigouroux, Action of Chloride of Silicon on Cobalt: Compt. Rend., Vol. CXLII, 1906, pp. 635-637.

Beckett, F. M., Alloy containing Iron, Cobalt, and Silicon. United States Patent, No. 1,247,206, Nov. 20th, 1917.

Cobalt and Silver

The cobalt-silver alloys have been investigated by Petrenko,[1] who found that cobalt and silver are practically insoluble in one another at temperatures up to 1600°C.

Additional References

Ducelliez, A Study of the Alloys of Cobalt and Silver: Bulletin Société Chimique de France, Vol. VII, 1910, pp. 506-507.

A Study of the Alloys of Cobalt and Silver: Procès verbaux de la Société des sciences physiques et naturelles de Bordeaux, 1909-1910, pp. 46-48.

Guertler, Metallographie, Vol. I, 1912, p. 100.

Cobalt and Sulphur

The equilibrium diagram of the cobalt-sulphur alloys from 0 to 35 per cent. sulphur, is shown in Figure 16.[2] The addition of sulphur to cobalt lowers the melting point from 1490°C. to the eutectic at 879°C. and 73.4 per cent. cobalt. This percentage corresponds closely to that of the formula Co_3S_2, but the eutectic is not a compound. The curve rises with further additions of sulphur to 935°C. and 70.7 per cent. cobalt. At this temperature the compound Co_4S_3 forms, and from 70.7 to 73.4 per cent. cobalt, a solid solution, V, of Co_4S_3 with cobalt exists. The liquidus curve rises finally to a maximum of 1130° and 68 per cent. cobalt, probably approaching the compound CoS.

The formation of the compound Co_4S_3 has not yet been finally accepted. However, there is evidence of a transformation occurring in the solid solution V at 830° and 790°C.

Cobalt and Thallium

The equilibrium diagram for the cobalt-thallium alloys is shown in Figure 17.[3] The metals are only partly soluble in one another in the liquid state. Thallium dissolves 2.8 per cent. cobalt, the melting point thereby being lowered

[1] Petrenko, Alloys of Silver with Iron, Nickel, and Cobalt: Zeitschr. anorg. Chemie, Vol. LIII, 1907, pp. 212-215.

[2] Guertler, Metallographie, Vol. I, pp. 981-982, 1912. Friedrich, Diagram of Cobalt-Sulphur Alloys: Metallurgie, Vol. V, 1908, pp. 212-215.

[3] Lewkonja, Cobalt-Thallium Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, pp. 318-319. Guertler, Metallographie, Vol. I, 1912, pp. 580-582.

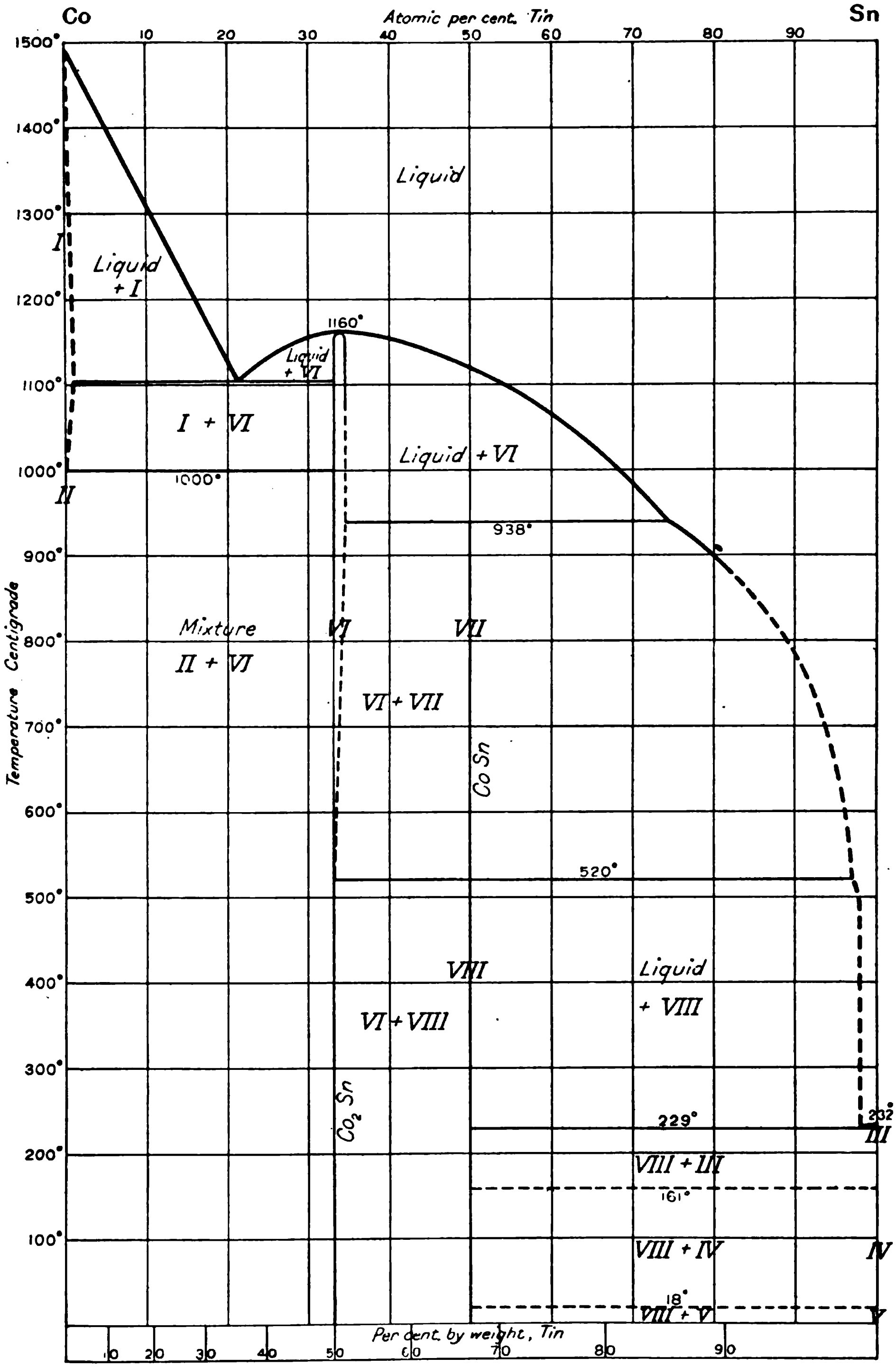

Figure 18.—Equilibrium Diagram of Cobalt-Tin Alloys.

6°C. Alloys with 10 per cent. cobalt show two layers. The boiling point of thallium lies very near the melting point of cobalt. Transformation lines are shown dotted in the diagram at 297° and 224°C.

Cobalt and Tin

The equilibrium diagram of the cobalt-tin alloys is shown in Figure 18.[1] The two metals are soluble in each other in the liquid state, but only to a small extent in the solid, cobalt retaining 2 per cent. tin at 1104°C. The addition of tin to cobalt lowers the melting point of cobalt from 1492° to the eutectic point at 1104°C. and 35 per cent. tin. With further additions of tin, the liquidus rises to a maximum at 1160°C. and 50 per cent. tin, which corresponds to the compound Co_2Sn. The curve falls with further additions of tin to 938°C., where a reaction occurs between the previously separated compound Co_2Sn and the liquid, containing 85 per cent. tin, to form a new compound CoSn. At 520°C., the compound CoSn undergoes a transformation to form a new crystal of similar composition. At 229°C. the eutectic of CoSn and tin occurs. Tin undergoes the usual transformation at 161° and 18°C.

Ducelliez[2] asserts that the compound Co_2Sn of Lewkonja is Co_3Sn_2, and has supported his assertion by numerous experiments.

An investigation of the effect of additions of cobalt on the mechanical and chemical properties of tin and bronze has been undertaken by Barth.[3] He found that adding up to 10 per cent. of cobalt to tin produced an increase in strength and an improvement in the working qualities. With 10 to 20 per cent. cobalt the alloy was a little brittle, about as hard as copper, and gray in colour. With 20 to 30 per cent. cobalt, the alloy had a smooth, bright, glassy fracture and was very hard and brittle. With 40 to 50 per cent. cobalt the hardness and brittleness increased, and the alloys broke into a number of pieces when cooling in the moulds. The alloy with 40 per cent. cobalt showed a conchoidal fracture, while that with 50 per cent. showed a very coarse crystalline structure. The alloys with more than 60 per cent. cobalt showed a finer grained, denser structure. These alloys were very hard and capable of taking a good polish.

The alloys with 20 to 50 per cent. cobalt were only slightly attacked by 60 per cent. nitric acid in five minutes. Molybdenum added to the 50 per cent. alloys did not show any advantage in the chemical tests.

A few experiments were made by Barth to investigate the effect of cobalt on the mechanical properties of bronze, but sufficient tests were not made to draw any definite conclusions.

Browne[4] made a few tests to determine the effect of cobalt (0 to 0.5 per cent.) on an alloy of the following composition: Cu 88, Sn 10, and Zn 2. The results, while encouraging, were not conclusive.

[1] Guertler, Metallographie, Vol. I, 1912, pp. 650-654.

[2] Ducelliez, Studies of the Alloys of Cobalt and Tin: Procès verbaux de la société des sciences physiques et naturelles de Bordeaux, 1907, pp. 51-55, 97-105, 115-119; Compt. Rend. Vol. CXLIV, 1907, pp. 1432-1434; Compt. Rend., Vol. 145, 1907, pp. 431, 502. A Study of the Electromotive Force of Cobalt-Tin Alloys: Bulletin Société Chimique de France, Vol. VII, 1910, pp. 205-206.

[3] Barth, Alloys of Increased Chemical Resistance and Good Mechanical Properties: Metallurgie, Vol. IX, 1911, pp. 261-270.

[4] Browne, Some Recent Applications of Metallic Cobalt: Trans. Amer. Inst. of Metals: Vol. VIII, 1914, pp. 61-67.

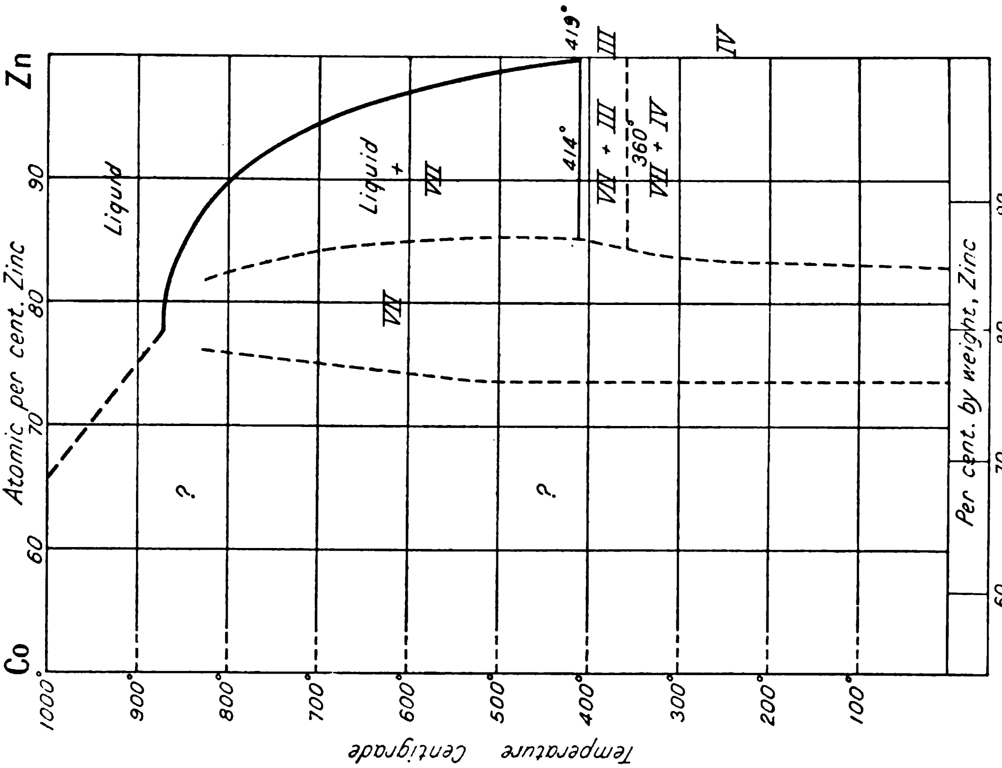

Figure 19.—Equilibrium Diagram of Cobalt-Zinc Alloys.

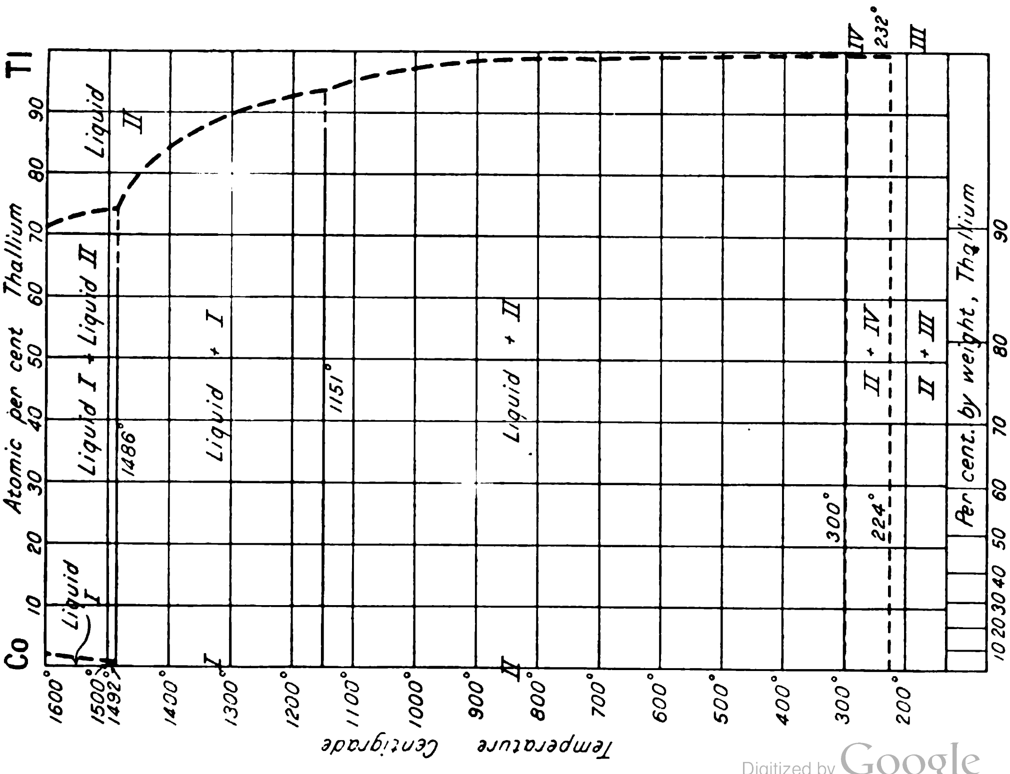

Figure 17.—Equilibrium Diagram of Cobalt-Thallium Alloys.

Additional References

Lewkonja, Cobalt-Tin Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, pp. 294-304.
Zemczuzny and Belynsky, Cobalt-Tin Alloys: Idem, pp. 364-370.
Bornemann, Cobalt and Tin: Metallurgie, Vol. VIII, 1911, pp. 291-292.
Kaiser, Analysis of a Tin Alloy (Sn 37, Ni 26, Bi 26, Co 11): Idem, p. 307.

Cobalt and Tungsten

The equilibrium diagram of the cobalt tungsten alloys has not yet been completely investigated. However, from the various tests that have been made, it appears that cobalt and tungsten form a complete series of solid solutions.

Reference

Guertler, Metallographie, Vol. I, 1912, p. 385.

Cobalt and Zinc

The equilibrium diagram of the cobalt-zinc alloys to 18 per cent. zinc is shown in Figure 19.[1] The addition of a small proportion (0.5 per cent.) of cobalt lowers the melting point of zinc to 414°C., 5° below the melting point. Further additions cause a rise in the liquidus, but melts containing more than 18 per cent. zinc could not be made because of the volatilization of the zinc. The curve even to 18 per cent. zinc has not been completely determined. On cooling alloys between 0.5 and 18 per cent. zinc, a solid solution varying in composition from 18.4 to 13.4 per cent. zinc separates. Melts with more than 12 per cent. zinc showed many rounded holes due to bubbles of zinc vapour.

The alloys from 0 to 18.4 per cent. cobalt were not magnetic.

Browne[2] made a few experiments with the addition of 0.5 per cent. cobalt to manganese bronze and brass containing 80 per cent. copper and 20 per cent. zinc. Sufficient tests were not made to warrant any definite statement as to the advantage of cobalt.

Additional References

Lewkonja, Cobalt-Zinc Alloys: Zeitschr. anorg. Chemie, Vol. LIX, 1908, pp. 319-322.
Ducelliez, Alloys of Cobalt and Zinc: Bulletin Société Chimique de France, Vol. IX, 1911, pp. 1017-1023.
Chemical Study of the Cobalt-Zinc Alloys: Procès verbaux de la société des sciences physiques et naturelles de Bordeaux, 1909-1910, pp. 102-107.
Electromotive Force of Cobalt-Zinc Alloys: Idem, 1909-1910, pp. 108-109.
Preparation and Properties of the Compound $CoZn_4$: Idem, pp. 109-111.

Cobalt and Zirconium

A patent[3] has been granted to H. S. Cooper covering the preparation of an alloy of cobalt and nickel with zirconium. The inventor claims that nickel and cobalt are hardened by additions of zirconium, and that the alloy so obtained is resistant to acids and alkalies, and possesses high electrical resistance. The melting point of nickel and cobalt is lowered by additions of zirconium, but the alloys cannot be forged, drawn, or rolled.

[1] Guertler, Cobalt and Zinc, Metallographie: Vol. I, 1912, pp. 444, 445.
[2] Browne, Some Recent Applications of Metallic Cobalt, Trans. Amer. Inst. of Metals, Vol. VIII, 1914, pp. 61-67.
[3] United States Patent, No. 1,221,769, April 3rd, 1917. Eng. Min. Jour., Vol. 105, 1918, p. 335.

Ternary Alloys of Cobalt

Very little has been done in the scientific investigation of the ternary alloys of cobalt, except in a few special cases which are mentioned mostly under the binary alloys. Most investigations of the ternary alloys have been done mainly with the object of finding some alloy valuable industrially. Janecke[1] has made an attempt to classify the ternary alloys of the metals, Cu, Ag, Au, Cr, Mn, Fe, Co, Ni, Pd, and Pt, but the classification could not be carried to a conclusion because all the binary diagrams have not been completely determined.

Eight groups are proposed by Janecke, viz., those in which

(*a*) Each of the binary systems possesses complete miscibility in the solid state.

(*b*) One of the binaries forms a eutectic or a transition point.

(*c*) One of the binary systems possesses a limited miscibility in the liquid state.

(*d*) One of the two binary systems possesses a limited miscibility in the liquid state, and the other a eutectic or transition point.

(*e*) Two of the binaries possess eutectic or transition points, or one a eutectic and the other a transition point.

(*f*) Two of the binary systems possess limited miscibility in the liquid state.

(*g*) Of the three binary systems one possesses a limited miscibility in the liquid state, and both the others have either eutectics or a eutectic and a transition point.

(*h*) Of the three binary systems, one possesses a eutectic and two a limited miscibility in the liquid state.

Group A

The ternaries of this group may be subdivided into four groups according as the system shows (1) no minimum, (2) one minimum, (3) two minima or (4) three minima. The CoNiFe and CoFeCr systems belong to the subdivisions 3 and 4 respectively. The different binary systems are briefly summarized below.

Ternary CoNiFe.	Ternary CoFeCr.
Co-Ni, no minimum.	Co-Cr minimum (c) 1340°C. (49p.c.Co).
Co-Fe minimum (a)[2] 1500°C. (50p.c.Co).	Co-Fe minimum (d) 1500°C. (50p.c.Co).
Ni-Fe minimum (b) 1464°C. (70p.c.Ni).	Cr-Fe minimum (e) 1440° C. (60p.c.Fe).

The systems CoNiFe may be represented diagramatically as in figure 20, while that of CoFeCr by figure 21.

Group B

The ternaries of this group are divided into two groups b_1 and b_2; b_1 in which one of the binaries shows a eutectic, and b_2 where one of the binaries shows a transition point. To b_1 belongs the system CrNiCo, and figure 22 represents it diagramatically. In the CrNiCo system Janecke gives a eutectic for the CrNi binary system.

[1] Janecke, The Ternary Alloys of the Metals, Cu, Ag, Au, Cr, Mn, Fe, Co, Ni, Pd, and Pt, Metallurgie, Vol. VII, 1910, pp. 510-523.

[2] The letters a, b, c, etc., refer to the points on the ternary diagrams.

System CrNiCo.

Cr-Ni minimum (f) 1300°C. (42p.c.Ni).
Cr-Co minimum (g) 1340°C. (49p.c.Co).
Ni-Co no minimum.

The system CoCuNi belongs under b_2 which is represented by figure 23.

System CoCuNi.

Co-Cu transition point (h) 1110°C. (96p.c.Cu).
Co-Ni no minimum.
Cu-Ni no minimum.

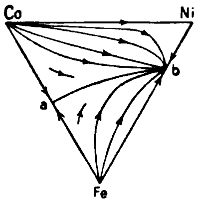

Fig. 20

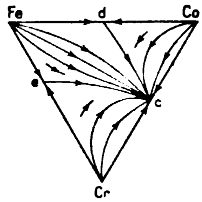

Fig. 21

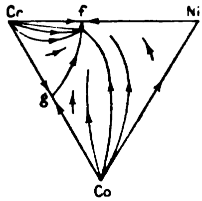

Fig. 22

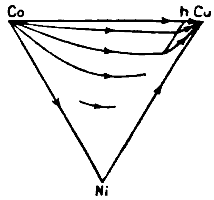

Fig. 23

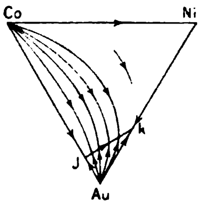

Fig. 24

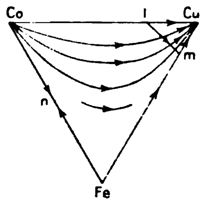

Fig. 25

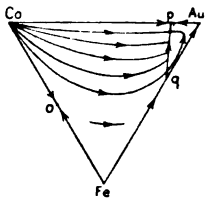

Fig. 26

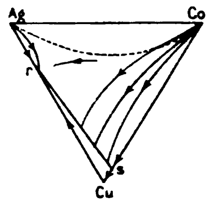

Fig. 27

Type Diagrams of some Ternary Cobalt Alloys

Group C

No system of this group is known in which all three binary mixtures have been investigated.

Group D

In Group D is given those systems in which there is in one of the binary systems a miscibility gap in the solid state, and in one of the others there occurs a gap in the liquid state. This group is subdivided according as to whether there is a eutectic (d_1) or a transition point (d_2) in one of the binary systems. The system AgCoAu belongs to d_1 while CuCrCo belongs to d_2.

System AgCoAu.

Ag-Co two liquids.
Ag-Au no minimum.
Co-Au eutectic 997°C. (90p.c.Au).

System CuCrCo.

Cu-Cr two liquids.
Cu-Co transition point.
Cr-Co minimum 1340°C. (49p.c.Co).

Group E

Group E consists of those systems in which two of the binaries show a miscibility gap in the solid state. There are three subdivisions of this group according as there are two eutectics (e_1); two transition points (e_2); or a eutectic and a transition point (e_3). To e_1 belongs CoNiAu, to e_2, CoFeCu, and to e_3, CoFeAu and AuCuCo.

System CoNiAu.
(figure 24).

Co-Ni no minimum.
Co-Au eutectic (j) 997°C. (90p.c.Au).
Ni-Au eutectic (k) 950°C. (27p.c.Ni).

System CoFeCu.
(figure 25).

Co-Fe minimum (n) 1500°C. (50p.c.Co).
Co-Cu transition point (l) 1110°C. (96p.c.Cu).
Fe-Cu transition point (m) 1100°C. (97p.c.Cu).

System AuCuCo.

Au-Cu minimum 884°C. (20p.c.Cu).
Au-Co eutectic 997°C. (90p.c.Au).
Cu-Co transition point 1110°C. (96p.c.Cu).

System CoFeAu.
(figure 26).

Co-Fe minimum (o) 1500°C. (50p.c.Co).
Co-Au eutectic (p) 997°C. (90p.c.Au).
Fe-Au transition point (q) 1168°C. (65p.c.Au).

Group F

In this group two of the binary mixtures show a separation into two liquids, and a transition takes place in the ternary system, so that there is not only a gap in the solid state but also one in the liquid state. The mixtures NiCoAg, CoFeAg, and CoCrAg belong to this group.

System NiCoAg.

Ni-Co no minimum.
Ni-Ag two liquids.
Co-Ag two liquids.

System CoFeAg.

Co-Fe minimum 1500°C.
Co-Ag two liquids.
Fe-Ag two liquids.

System CoCrAg.

Co-Cr minimum 1320°C.
Co-Ag two liquids.
Cr-Ag two liquids.

Group G

Of the three binary systems one possesses a limited miscibility in the liquid state, and both the others have either eutectics or a eutectic and a transition point. The ternary mixture of this group may be represented by AgCoCu, figure 27.

System AgCoCu.
(figure 27).

Ag-Co two liquids.
Ag-Cu eutectic (r) 778°C. (28p.c.Cu).
Co-Cu transition point (s) 1110°C. (96p.c.Cu).

Group H

The binary systems of group H are the reverse of those of G. There is one eutectic, and two form two liquid layers in the binary system. No cobalt alloys are given at present under this heading.

In addition to the preceding summary by Janecke, other investigators have made experiments dealing with ternary alloys of cobalt, especially as regards their chemical and mechanical properties. A list of these is given below and a summary of the properties of the various ternaries appears under the description of the binary alloys. In order to enable ready reference to the different binaries for the summary of the ternaries, the metals are arranged in the following list so that by referring to the binary alloy of cobalt with the metal mentioned second, a description of the ternary will be found along with the references to original articles.

Cobalt-chromium-tungsten.
Cobalt-chromium-molybdenum.
Cobalt-copper-aluminium (white bronze).
Cobalt-copper-aluminium-iron (metalline).
Cobalt-iron-carbon. *See* effect of cobalt on steel.
Cobalt-nickel-silver.
Cobalt-nickel-chromium and other metals.
Cobalt-nickel-copper.
Cobalt-tin-copper.
Cobalt-tin-copper. Addition of cobalt to bronze.
Cobalt-zinc-copper. Addition of cobalt to brass.

Additional References to Alloys

Ducelliez. Researches on the Alloys of Cobalt, Thèse, Bordeaux, 1911. (Note.—A copy of this paper could not be obtained in any of the largest libraries on this continent. However, the writer believes most of the separate papers are mentioned under the alloys of cobalt with the different metals.)

Guertler, On the magnetizability of the alloys of ferro-magnetic metals: Zeitschr. physikal. Chemie, Vol. 65, 1908, pp. 73-83.

Fahrenwald, Ternary Alloys of Palladium and Gold with Cobalt, Chem. Abst., Vol. eleven, 1917, p. 1,620.

Acknowledgments

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END OF SECTION I.

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